IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

ASUS TECHNOLOGY LICENSING INC. AND CELERITY IP, LLC,

Plaintiffs,

v.

SAMSUNG ELECTRONICS CO., LTD., SAMSUNG ELECTRONICS AMERICA, INC., AND SAMSUNG RESEARCH AMERICA,

Defendants.

Civil Action No. No. 2:23-cv-409

JURY TRIAL DEMANDED

FIRST AMENDED COMPLAINT

Plaintiffs ASUS Technology Licensing Inc. ("ATL") and Celerity IP, LLC ("Celerity") (collectively, "Plaintiffs") hereby submit this First Amended Complaint for patent infringement against Defendants Samsung Electronics Co., Ltd., Samsung Electronics America, Inc., and Samsung Research America (collectively, "Samsung" or "Defendants") and state as follows:

NATURE OF THE ACTION

1. Samsung has infringed and continues to infringe, contribute to the infringement of, and/or actively induce others to infringe, U.S. Patent No. 10,187,878 ("the '878 Patent"), 11,291,052 ("the '052 Patent"), 10,104,658 ("the '658 Patent"), 10,785,759 ("the '759 Patent"), and 10,986,585 ("the '585 Patent") (collectively, the "Patents-In-Suit") (attached hereto as Exhibits A-E). Plaintiffs accordingly file this Complaint seeking a judgment of and relief for patent infringement by Samsung.

THE PARTIES

2. Plaintiff ASUS Technology Licensing Inc. ("ATL") is Taiwanese corporation, with its principal place of business located at No. 115, Li-De Rd., Beitou District, Taipei, Taiwan, R.O.C. ATL was established in April 2022 by ASUSTeK Computer Inc. ("ASUSTeK") to continue ASUSTeK's long history of development in and contributions to the field of wireless communication technologies since 2000. ATL's mission includes active development of 3G, 4G, and 5G wireless communication technologies, as well as management of an innovative patent portfolio concerning such technologies which has brought abounding contributions to the industry through standards contributions and licensing. ATL is the owner by assignment of patents, originally owned by ASUSTeK, that are critically important to 3G, 4G, and 5G technologies. Regarding the present litigation, ATL is the owner by assignment of the Patents-In-Suit.

3. Plaintiff Celerity IP, LLC ("Celerity") is a limited liability company organized and existing under the laws of Texas, with its principal place of business located at 7160 Dallas Parkway, Suite 235, Plano, Texas 75024. Celerity has partnered with ATL to assist with the licensing and enforcement of ATL's patents, including in the present litigation. Celerity is the exclusive licensee of the Patents-In-Suit. While Celerity is the exclusive licensee of the Patents-In-Suit, patent owner ATL has agreed to join as a Plaintiff in the present litigation, including to ensure compliance with 35 U.S.C. § 281. *See Lone Star Silicon Innovations LLC v. Nanya Technology Corp.*, 925 F.3d 1225 (Fed. Cir. 2019).

4. Defendant Samsung Electronics Co., Ltd. ("SEC") is a corporation organized and existing under the laws of the Republic of Korea, with its principal place of business located at 129 Samsung-ro, Maetan-3dong, Yeongtong-gu Suwon-si, Gyeonggi-do 16677, Suwon-Shi, Korea.

5. Defendant Samsung Electronics America, Inc. ("SEA") is a corporation organized and existing under the laws of New York, with its principal place of business located at 85

Challenger Road, Ridgefield Park, New Jersey 07660. Since at least June 10, 1996, SEA has been registered to do business in Texas under Texas SOS file number 0011028006. SEA may be served through its registered agent, CT Corporation System, located at 1999 Bryan St., Ste. 900, Dallas, Texas 75201. On information and belief, SEA is a direct or indirect subsidiary of SEC.

6. Defendant Samsung Research America ("SRA") is a corporation organized and existing under the laws of California, with its principal place of business located at 645 Clyde Avenue, Mountain View, California 94043. Since at least January 26, 2012, SRA has been registered to do business in Texas under Texas SOS file number 0801541089. SRA may be served through its registered agent, CT Corporation System, located at 1999 Bryan St., Ste. 900, Dallas, Texas 75201. On information and belief, SRA is a direct or indirect subsidiary of SEC.

JURISDICTION AND VENUE

7. This Court has subject matter jurisdiction pursuant to 28 U.S.C. § 1331 and 1338, as this action arises under the patent laws of the United States (35 U.S.C. §§ 1 *et seq.*).

8. Each Defendant is subject to this Court's personal jurisdiction consistent with the principles of due process and/or the Texas Long Arm Statute.

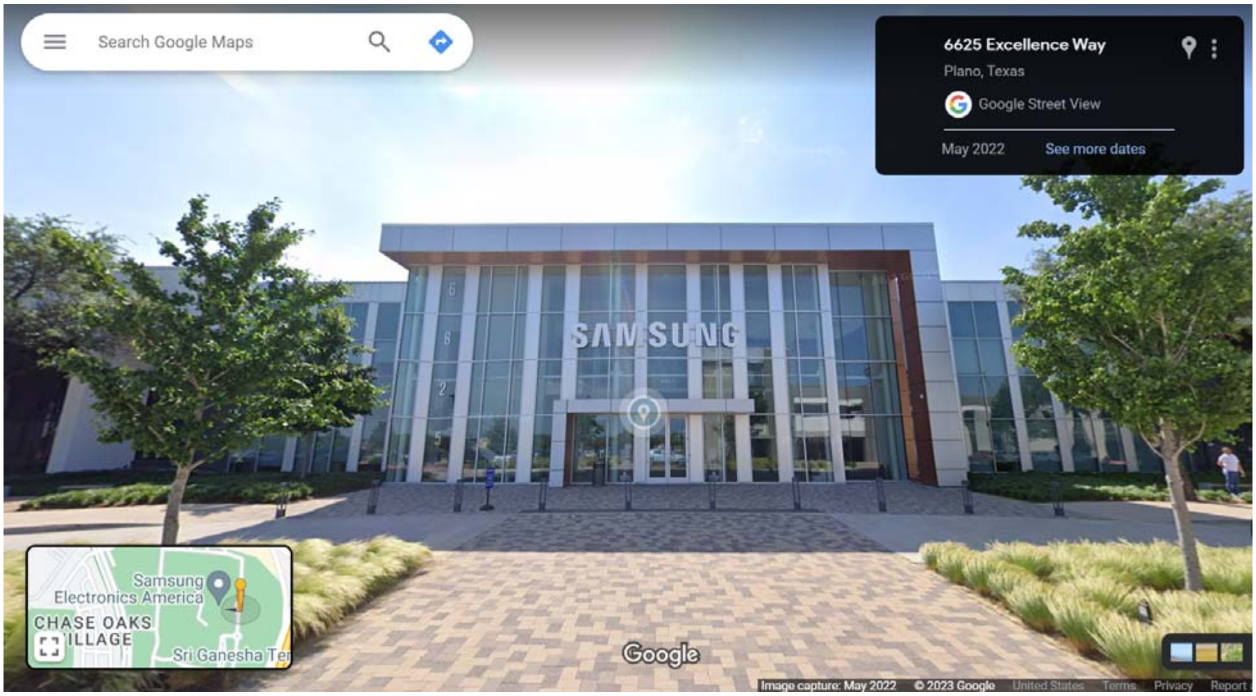
9. Personal jurisdiction exists generally over the Defendants because each Defendant has sufficient minimum contacts and/or has engaged in continuous and systematic activities in the forum as a result of business conducted within Texas, including in the Eastern District of Texas. Personal jurisdiction also exists over each Defendant because each, directly or through subsidiaries, makes, uses, sells, offers for sale, imports, advertises, makes available, and/or markets products and/or services within Texas, including in the Eastern District of Texas, that infringe one or more claims of the Patents-In-Suit. Further, on information and belief, Defendants have placed or contributed to placing infringing products and/or services into the stream of commerce knowing or understanding that such products and/or services would be sold and used in the United States, including in this District. Defendants SEA and SRA are each registered to

do business in Texas and maintain an agent authorized to receive service of process within Texas, and Defendant SEC is the direct or indirect parent corporation of Defendants SEA and SRA.

10. Venue is proper in the Eastern District of Texas pursuant to 28 U.S.C. §§ 1391(b)-(c) and/or 1400(b), including but not limited to because Samsung has committed acts of infringement in this District and has regular and established places of business in this District. By way of example and without limitation, Samsung makes, uses, sells, offers to sell, and/or imports products and/or services that are accused of infringing the Patents-In-Suit into and/or within this District and maintains a permanent and/or continuing presence within this District. Additionally, upon information and belief, Defendants SEA and SRA maintain places of business in this District, and Defendant SEC is a foreign company with no place of business in the United States apart from those of its subsidiaries (including SEA and SRA).

11. Plaintiffs maintain a place of business within the Eastern District of Texas. For example, Plaintiff Celerity is incorporated in Texas and has its principal place of business within this District located at 7160 Dallas Parkway, Suite 235, Plano, Texas 75024.

12. Defendants likewise maintain multiple places of business within this District. For example, Defendant SEA maintains its "Flagship North Texas Campus" in this District, which it opened in 2019 with a "216,000 square foot building" and "more than 1,000 regional employees." https://news.samsung.com/us/samsung-electronics-america-open-flagship-north-texas-campus/ (last visited Sept. 12, 2023). This facility is located at 6625 Excellence Way, Plano, Texas 75023:



https://www.google.com/maps/ (6625 Excellence Way, Plano, Texas) (last visited Sept. 12, 2023). Since opening SEA's North Texas Campus in 2019, Samsung has further expanded its Plano footprint multiple times, including, for example, with the addition of locations at 6625 Declaration Way, Plano, Texas 75023, and at 6105 Tennyson Parkway, Plano, Texas 75023. *See, e.g*, https://www.dallasnews.com/business/retail/2023/01/06/samsung-growing-in-north-texas-with-offices-in-plano-and-coppell-warehouse/ (last visited Sept. 12, 2023) ("In 2020, Samsung expanded the Plano office by another 75,000 square feet, according to planning documents filed with the state. Then in 2021, Samsung added another 60,000 square feet of offices in the Legacy Central building at 6625 Declaration Way. Now Samsung is taking 33,226 square feet of offices in another Plano building. The South Korea-based company has leased the third floor in The Tennyson office campus at 6105 Tennyson Parkway in Legacy business park.").

13. Moreover, for example, Defendant SRA maintains an office within the Eastern District of Texas, which is also located in the facility at 6625 Excellence Way, Plano, Texas 75023:

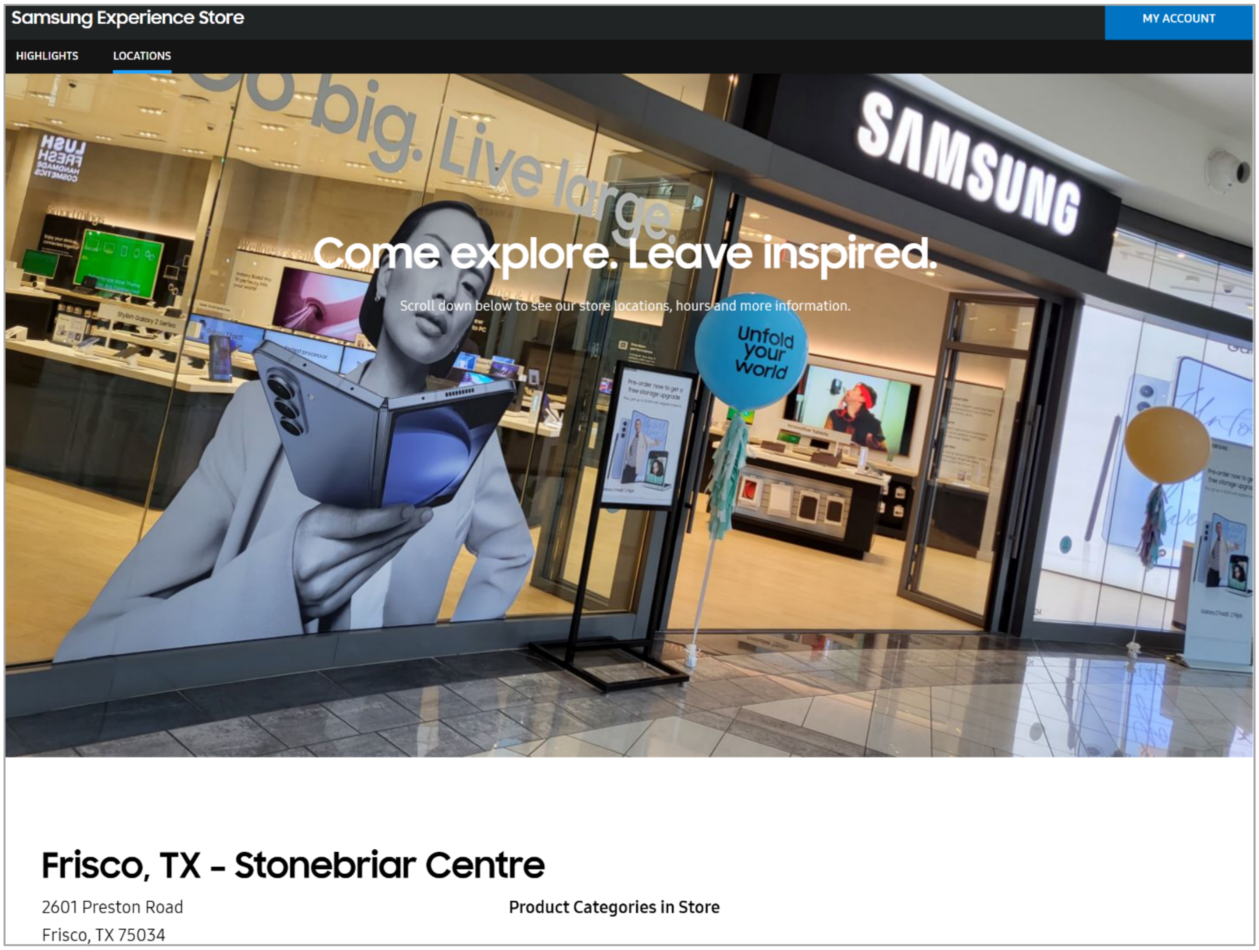
Our locations

Plano, TX

6625 Excellence Way
Plano, TX 75023
Get directions

https://sra.samsung.com/locations/ (last visited Sept. 12, 2023). SRA employees at this location work on research and development relating to the implementation of 5G technologies in Samsung products. *See* https://research.samsung.com/sra (last visited Sept. 12, 2023) ("Samsung Research America plays a critical role in developing next generation software, user experiences, and services for Samsung Electronics in key domains, such as … 5G/6G communication networks ….").

14. Further, for example, Samsung also maintains a "Samsung Experience Store" within the Eastern District of Texas, located at 2601 Preston Rd. #1214, Frisco, Texas 75034:



https://www.samsung.com/us/samsung-experience-store/locations/ (last visited Sept. 12, 2023). At this facility, Samsung invites its customers "to shop our Galaxy of products, learn directly from experts and get Samsung-certified service and repairs." https://www.samsung.com/us/samsung-experience-store/ (last visited Sept. 12, 2023).

15. Samsung has solicited business in the Eastern District of Texas, has transacted business within this District, and has attempted to derive financial benefit from the residents of this District, including benefits directly related to Samsung's infringement of the Patents-In-Suit.

16. In other recent actions, Samsung has either admitted or not contested that the Eastern District of Texas is a proper venue for patent infringement actions against it. *See, e.g.*, *5G IP Holdings LLC v. Samsung Electronics Co., Ltd.*, *Samsung Electronics America, Inc., and Samsung Research America*, No. 4:21-cv-00622-SDJ, Dkt. 23 ¶ 19 (E.D. Tex. Nov. 15, 2021) ("Samsung does not challenge that venue is proper in this judicial district under 28 U.S.C.

§ 1391(b)-(c) and 14000(b) for purposes of this case ...."); *CogniPower LLC v. Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc.*, No. 2:23-cv-00160-JRG, Dkt. 29 ¶¶ 12-13 (E.D. Tex. July 31, 2023) (Samsung not contesting that venue is proper in this judicial district under 28 U.S.C. §§ 1391 and 1400(b)).

17. Defendants are properly joined under 35 U.S.C. § 299(a) because, on information and belief, Defendants commonly and/or jointly make, use, sell, offer to sell, and/or import the Samsung Accused Products such that at least one right to relief is asserted against Defendants jointly, severally, and in the alternative with respect to or arising out of the same transaction, occurrence, or series of transactions or occurrences relating to the making, using, selling, offering to sell, and/or importing into the United States of the same Samsung Accused Products, and such that questions of fact common to all Defendants will arise in this action.

PATENTS-IN-SUIT

18. U.S. Patent No. 10,187,878 ("the '878 Patent") was duly and legally issued on January 22, 2019, for an invention titled, "Method And Apparatus For Improving A Transmission Using A Configured Resource In A Wireless Communication System."

19. U.S. Patent No. 11,291,052 ("the '052 Patent") was duly and legally issued on March 29, 2022, for an invention titled, "Method And Apparatus For Improving Msg3 Transmission Of Random Access Procedure In A Wireless Communication System."

20. U.S. Patent No. 10,104,658 ("the '658 Patent") was duly and legally issued on October 16, 2018, for an invention titled, "Method And Apparatus For Delivery Of Control Signaling In A Wireless Communication System."

21. U.S. Patent No. 10,785,759 ("the '759 Patent") was duly and legally issued on September 22, 2020, for an invention titled, "Method And Apparatus For Determining Numerology Bandwidth In A Wireless Communication System."

22. U.S. Patent No. 10,986,585 ("the '585 Patent") was duly and legally issued on April 20, 2021, for an invention titled, "Method And Apparatus For Triggering Power Headroom Report For Multiple Pathloss Reference In A Wireless Communication System."

23. Plaintiffs own all rights to the Patents-In-Suit that are necessary to bring this action, including all rights to sue for infringement and to recover past and future damages. Celerity is the exclusive licensee of the Patents-In-Suit, and ATL is the owner by assignment of the Patents-In-Suit. Patent owner ATL has voluntarily joined as a Plaintiff in this litigation.

24. Samsung is not currently licensed to practice the Patents-In-Suit.

25. The Patents-In-Suit are valid and enforceable.

26. Samsung has had knowledge of the Patents-In-Suit at least since January 19, 2022 for the '878, '759, and '585 Patents, June 22, 2023 for the '658 Patent, and August 22, 2023 for the '052 Patent, when Plaintiffs provided Samsung notice that it is infringing the Patents-In-Suit.

SAMSUNG ACCUSED PRODUCTS

27. On information and belief, Samsung makes, uses, sells, offers for sale, and/or imports, in/into the United States, products that implement and practice 4G wireless technologies (the “Samsung 4G Accused Products”). The Samsung 4G Accused Products include, but are not limited to: Galaxy Z Flip series including Galaxy Z Flip5, Galaxy Z Flip4, Galaxy Z Flip3, Galaxy Z Flip; Galaxy Z Fold series including Galaxy Z Fold5, Galaxy Z Fold4, Galaxy Z Fold3, Galaxy Z Fold2, Galaxy Z Fold; Galaxy A series including Galaxy A80, Galaxy A73, Galaxy A72, Galaxy A71, Galaxy A70s, Galaxy A70, Galaxy A60, Galaxy A53, Galaxy A52, Galaxy A51, Galaxy A50, Galaxy A50s, Galaxy A42, Galaxy A41, Galaxy A40, Galaxy A33, Galaxy A32, Galaxy A31, Galaxy A30, Galaxy A30s, Galaxy A23, Galaxy A22, Galaxy A21, Galaxy A20s, Galaxy A20e, Galaxy A14, Galaxy A13, Galaxy A12, Galaxy A11, Galaxy A10e, Galaxy A10s, Galaxy A10, Galaxy A9, Galaxy A8Star, Galaxy A8s, GalaxyA8+, Galaxy A8, Galaxy A7, Galaxy A6, GalaxyA6+, GalaxyA6s, Galaxy A5, Galaxy A3, Galaxy A2core, Galaxy A04s, Galaxy A04,

Galaxy A03s, Galaxy A03, Galaxy A02s, Galaxy A02; Galaxy A01; Galaxy S Series including Galaxy S24 Ultra, Galaxy S24+, Galaxy S24, Galaxy S23 FE, Galaxy S23 Ultra, Galaxy S23+, Galaxy S23, Galaxy S22+, Galaxy S22 Ultra, Galaxy S22, Galaxy S21+, Galaxy S21, Galaxy S21 Ultra, Galaxy S21 FE, Galaxy S20+, Galaxy S20 FE, Galaxy S10+, Galaxy S10E, Galaxy S10, Galaxy S9+, Galaxy S9, Galaxy S8 Active, Galaxy S8; Galaxy M Series including Galaxy M62, Galaxy M53, Galaxy M52, Galaxy M51, Galaxy M40, Galaxy M32, GalaxyM31s, GalaxyM31, Galaxy M30s, Galaxy M30, Galaxy M23, Galaxy M22, GalaxyM21s, Galaxy M21, Galaxy M20, Galaxy M13, Galaxy M12, Galaxy M11, Galaxy M10s, Galaxy M10, Galaxy M04, Galaxy M02s, Galaxy M02, Galaxy M01s, Galaxy M01; Galaxy J Series including Galaxy J8, Galaxy J7, Galaxy J6, Galaxy J5, Galaxy J4, Galaxy J3, Galaxy J2; Galaxy Note series including Galaxy Note20, Galaxy Note 10+, Galaxy Note 10, Galaxy Note9, Galaxy Note 8, Galaxy Note FE; Galaxy Tab series including Galaxy Tab S9, Galaxy Tab S9+, Galaxy Tab S9 Ultra, Galaxy Tab S8+, Galaxy TabS8 Ultra, Galaxy Tab S8, Galaxy TabS7+, Galaxy TabS7, Galaxy Tab S6, Galaxy TabS5e, Galaxy Tab S4, Galaxy TabS3, Galaxy Tab A 8.0, Galaxy Tab A 10.5, Galaxy Tab A 10.1, Galaxy Tab A8.4, Galaxy Tab A7, Galaxy Tab A7 Lite, Galaxy TabA8; Galaxy Watch series including Galaxy Watch 6, Galaxy Watch 5, Galaxy Watch 4, Galaxy Watch 3, Galaxy Watch Active 2, Galaxy Watch Active, Galaxy Watch; Galaxy XCover series including Galaxy XCover 6 Pro, Galaxy XCover5, Galaxy XCover4, Galaxy XCover Pro.

28. On information and belief, Samsung makes, uses, sells, offers for sale, and/or imports, in/into the United States, products that implement and practice 5G wireless technologies (the "Samsung 5G Accused Products"). The Samsung 5G Accused Products include, but are not limited to: Galaxy Z Fold series including Galaxy Z Fold5, Galaxy Z Fold4, Galaxy Z Fold3, Galaxy Z Fold2 5G, Galaxy Z Fold 5G; Galaxy Z Flip series including Galaxy Z Flip5, Galaxy Z Flip4, Galaxy Z Flip3 5G, Galaxy Z Flip 5G; Galaxy S series including Galaxy S24 Ultra, Galaxy S24+, Galaxy S24, Galaxy S23 FE, Galaxy S23 Ultra, Galaxy S23+, Galaxy S23, Galaxy S22

Ultra, Galaxy S22+, Galaxy S22, Galaxy S21 FE 5G, Galaxy S21 Ultra 5G, Galaxy S21+ 5G, Galaxy S21, Galaxy S20 FE 5G, Galaxy S20 FE 5G UW, Galaxy S20 Ultra 5G, Galaxy S20+ 5G, Galaxy S20 5G, Galaxy S10 5G; Galaxy Note series including Galaxy Note20 Ultra 5G, Galaxy Note20 5G, Galaxy Note 10+ 5G; Galaxy A series including Galaxy A90 5G, Galaxy A73 5G, A71 5G, Galaxy A71 5G UW, Galaxy A54 5G, Galaxy A53 5G, Galaxy A52s 5G, Galaxy A52 5G, Galaxy A51 5G, Galaxy A51 5G UW, Galaxy A42 5G, Galaxy A34 5G, Galaxy A33 5G, Galaxy A32 5G, Galaxy A24 5G, Galaxy A23 5G, Galaxy A22 5G, Galaxy A14 5G, Galaxy A13 5G; Galaxy Tab series including Galaxy Tab S9+, Galaxy S9 FE 5G, Galaxy Tab S8+ 5G, Galaxy Tab S8, Galaxy TabS8 Ultra, Galaxy Tab S7 5G, Galaxy Tab S7+ 5G, Galaxy Tab S7 FE 5G, Galaxy Tab 6 5G; Galaxy M Series including Galaxy M54 5G, Galaxy M53 5G, Galaxy M52 5G, Galaxy M42 5G, Galaxy M34 5G, Galaxy M33 5G, Galaxy M32 5G, Galaxy M23 5G, Galaxy M14 5G, Galaxy M13 5G; Galaxy XCover series including Galaxy XCover 6 Pro. On information and belief, as of the filing of this Complaint, all Samsung 5G Accused Products are also Samsung 4G Accused Products, as Samsung products with 5G capabilities also have 4G capabilities (including, for example, to use 4G networks in locations where there may be inadequate 5G network coverage).

29. As referenced in this Complaint, all of the Samsung 4G Accused Products and Samsung 5G Accused Products are referred to, collectively, as the "Samsung Accused Products."

PLAINTIFFS' COMPLIANCE WITH THE ETSI IPR POLICY AND DEFENDANTS' FAILURE TO COMPLY

30. The European Telecommunications Standards Institute ("ETSI") is an independent, non-profit standard setting organization ("SSO") that produces globally-accepted standards in the telecommunications industry. In addition to its own activities, ETSI is also one of several SSOs that are organization partners of the Third Generation Partnership Project ("3GPP"), which maintains and develops globally applicable technical specifications and standards, including for 4G wireless technologies (the "4G Standard") and 5G wireless technologies (the "5G Standard").

ETSI and its members have developed global standards that ensure worldwide interoperability between wireless networks, network operators, and devices.

31. ETSI has developed and promulgated an ETSI IPR Policy, which is intended to strike a balance between the need for open standards on the one hand, and the rights of IPR owners on the other hand. Clause 15.6 of the ETSI IPR Policy defines the term "ESSENTIAL" to mean that "it is not possible on technical (but not commercial) grounds, taking into account normal technical practice and the state of the art generally available at the time of standardization, to make, sell, lease, otherwise dispose of, repair, use or operate EQUIPMENT or METHODS which comply with a STANDARD without infringing that IPR." ETSI IPR Policy § 15.6 (Nov. 30, 2022).

32. In an abundance of caution and to ensure their compliance with the ETSI IPR Policy, the Plaintiffs informed Samsung that they were prepared to grant Samsung an irrevocable license to the Plaintiffs' patents that relate to 4G and/or 5G wireless technologies, including to the Patents-In-Suit, on license terms that are Fair, Reasonable, and Non-Discriminatory ("FRAND"). The ETSI IPR Policy entitles a FRAND license to implementers that "MANUFACTURE …, sell, lease, or otherwise dispose of, … repair, use, or operate EQUIPMENT," and/or "use METHODS":

6 Availability of Licences

6.1 When an ESSENTIAL IPR relating to a particular STANDARD or TECHNICAL SPECIFICATION is brought to the attention of ETSI, the Director-General of ETSI shall immediately request the owner to give within three months an irrevocable undertaking in writing that it is prepared to grant irrevocable licences on fair, reasonable and non-discriminatory ("FRAND") terms and conditions under such IPR to at least the following extent:

- MANUFACTURE, including the right to make or have made customized components and sub-systems to the licensee's own design for use in MANUFACTURE;
- sell, lease, or otherwise dispose of EQUIPMENT so MANUFACTURED;
- repair, use, or operate EQUIPMENT; and
- use METHODS.

The above undertaking may be made subject to the condition that those who seek licences agree to reciprocate.

ETSI IPR Policy § 6.1 (Nov. 30, 2022).

33. Not later than January 19, 2022, the Plaintiffs sent to Samsung correspondence initiating the Plaintiffs' good faith efforts to license their patents to Samsung on FRAND terms.

34. Following the Plaintiffs' January 19, 2022 notice to Samsung, including for more than 18 months thereafter, the Plaintiffs' representatives routinely corresponded with Samsung representatives. During such correspondence, the Plaintiffs' representatives provided, in good faith, materials concerning the Plaintiffs' patents and technical details evidencing Samsung's use of the Plaintiffs' patents, including the Patents-In-Suit.

35. The Plaintiffs' representatives have provided Samsung multiple opportunities to license the Plaintiffs' patents on FRAND terms.

36. To date, Samsung has not reciprocated the Plaintiffs' good faith efforts to negotiate a FRAND license. Samsung has failed to negotiate in good faith. Samsung has instead declined to take a license to the Plaintiffs' valuable intellectual property, including the Patents-In-Suit.

37. Samsung has operated and continues to operate the Samsung Accused Products without a license to the Plaintiffs' patents, including the Patents-In-Suit. Given Samsung's unwillingness to license the Plaintiffs' patents, or to cease its infringement, the Plaintiffs have filed this lawsuit for the purpose of protecting their patent rights in the United States.

38. The parties' licensing negotiations have been unsuccessful because Samsung has refused to engage in a good faith licensing discussion concerning the Plaintiffs' valuable patents.

GENERAL INFRINGEMENT ALLEGATIONS

39. Samsung makes, uses, sells, offers for sale, and/or imports, in this District and/or elsewhere in the United States, the Samsung Accused Products that infringe the Patents-In-Suit. For example, and as will be outlined further below, the Samsung Accused Products infringe the Patents-In-Suit by virtue of their compatibility with and practice of the 4G and/or 5G Standards.

40. Samsung first began adding 4G technology (also sometimes referred to as "LTE" or "4G LTE") to its mobile consumer product lineup well over a decade ago. *See, e.g.*,

https://www.wired.com/2010/06/samsung-4g-phone-sprint/ (June 2010: "Samsung has introduced its first 4G handset, called the Samsung Epic, on Sprint's network.") (last visited Sept. 12, 2023). On information and belief, since at least six (6) years before the filing of this Complaint (*see* 35 U.S.C. § 286) through the present, virtually all of Samsung's phones, and many other products such as tablets, laptops, and watches, have been compatible with and practice the 4G Standard.

41. Samsung began adding 5G technology to its mobile consumer product lineup by at least 2019. *See, e.g.*, https://www.samsung.com/us/mobile/5g/evolution-to-5g/ (last visited Sept. 12, 2023) ("In 2019, Samsung introduced its first line of 5G-Ready devices …."). Samsung touted that its initial 5G products were "capable of providing streaming, downloading, and browsing at 3x the speed of 4G." *Id.* Since then, Samsung rapidly scaled its 5G rollout, reporting: "In 2020, Samsung continues to commit to pushing 5G innovation forward. Our family of 5G devices is flourishing, growing from two powerful smartphones to an entire line of HyperFast products." *Id.* Additionally, on information and belief, as of the filing of this Complaint, all of the 5G capable products Samsung has released to date are backwards compatible with 4G technology.

42. Samsung has frequently touted the benefits of 4G and 5G technologies in the Samsung Accused Products. For example, as Samsung presently states on its website: "The advancements of 4G LTE provided the speed to support rich gaming platforms, HD mobile TV, and video conferencing." https://www.samsung.com/us/mobile/5g/evolution-to-5g/ (last visited Sept. 12, 2023). At its initial rollout of 5G products, Samsung touted that its "5G-Ready devices" were capable of connectivity "3x the speed of 4G." *Id.* Today, Samsung advertises that "[i]t's all possible with 5G: From smooth-as-silk gaming to streaming, shopping and working all at once, Samsung elevates every day with unique 5G devices." https://www.samsung.com/us/mobile/5g/ (last visited Sept. 12, 2023). Samsung touts that, "[f]rom visiting new shops in the metaverse to meeting friends at virtual concerts, Samsung 5G devices can give you the speed and connectivity to keep up." *Id.* According to Samsung, its "Galaxy 5G devices give you the next-level

connectivity to control it all like a symphony. Effortless multitasking. Crisp HD video chatting. Seamless connections to your tablet, buds, and even your fridge and range." *Id.*

43. Samsung has directly and indirectly infringed, and continues to directly and indirectly infringe, the Patents-In-Suit by engaging in acts constituting infringement under 35 U.S.C. § 271(a), (b), (c), and/or (f), including but not limited to making, using, selling and offering to sell, in this District and elsewhere in the United States, and importing into the United States, the Samsung Accused Products that infringe the Patents-In-Suit.

44. Samsung has directly infringed and continues to directly infringe the Patents-In-Suit, as provided in 35 U.S.C. § 271(a), including at least by Samsung making, using, selling, offering to sell, and/or importing the Samsung Accused Products. For example, and as will be outlined further below, the Samsung Accused Products infringe the Patents-In-Suit by virtue of their compatibility with and practice of the 4G and/or 5G Standards.

45. Samsung has also indirectly infringed and continues to indirectly infringe the Patents-In-Suit, as provided in 35 U.S.C. § 271(b), including at least by inducing infringement by others, such as Samsung's customers and end-users, in this District and elsewhere in the United States, to use the Samsung Accused Products in manners that infringe the Patents-In-Suit. For example, Samsung's customers and end-users directly infringe via their use of the Samsung Accused Products to access and use 4G and 5G wireless technologies, infringing the Patents-In-Suit. Samsung induces such direct infringement through its affirmative acts of making, using, selling, offering to sell, and/or importing the Samsung Accused Products, as well as by advertising its 4G and 5G wireless technologies and providing instructions, documentation, and other information to its customers and end-users to encourage and teach them how to use the infringing 4G and 5G wireless technologies, including but not limited to by Samsung providing in-store and online technical support, marketing materials, product manuals, advertisements, and other product

documentation. Samsung performs these affirmative acts with knowledge of the Patents-In-Suit and with the intent, or willful blindness, that the induced acts directly infringe the Patents-In-Suit.

46. Samsung has also indirectly infringed and continues to indirectly infringe the Patents-In-Suit, as provided by 35 U.S.C. § 271(c), by contributing to direct infringement committed by others, such as Samsung's customers and end-users, in this District and elsewhere in the United States. Samsung's affirmative acts of selling and offering to sell the Samsung Accused Products in this District and elsewhere in the United States, and causing the Samsung Accused Products to be manufactured, used, sold, and offered for sale, contribute to Samsung's customers and end-users using the Samsung Accused Products, such that the Patents-In-Suit is directly infringed. The accused components in the Samsung Accused Products are material to the inventions claimed in the Patents-In-Suit, are not staple articles or commodities of commerce, have no substantial non-infringing uses, and are known by Samsung to be especially made or adapted for use in the infringement of the Patents-In-Suit. Samsung performs these affirmative acts with knowledge of the Patents-In-Suit and with the intent, or willful blindness, that they cause direct infringement of the Patents-In-Suit.

47. Samsung has also infringed and continues to infringe the Patents-In-Suit, as provided by 35 U.S.C. § 271(f)(1), by supplying or causing to be supplied in or from the United States all or a substantial portion of the components of the Samsung Accused Products, uncombined in whole or in part, in such a manner as to actively induce their combination outside the United States in a manner that would infringe the Patents-In-Suit if such combination occurred within the United States. Samsung has likewise infringed and continues to infringe the Patents-In-Suit, as provided by 35 U.S.C. § 271(f)(2), by supplying or causing to be supplied in or from the United States components of the Samsung Accused Products that are especially made or especially adapted for infringement of the Patents-In-Suit. The accused components in the Samsung Accused Products are material to the inventions claimed in the Patents-In-Suit, are not

staple articles or commodities of commerce, have no substantial non-infringing uses, and are known by Samsung to be especially made or adapted for use in the infringement of the Patents-In-Suit. Samsung performs these affirmative acts with knowledge of the Patents-In-Suit and with the intent, or willful blindness, that they cause direct infringement of the Patents-In-Suit.

48. Samsung's infringement of the Patents-In-Suit has caused damage to the Plaintiffs. The Plaintiffs are entitled to recover from Samsung the damages sustained by the Plaintiffs as a result of Samsung's wrongful acts in an amount subject to proof at trial.

49. Samsung's infringement of the Patents-In-Suit has been and continues to be willful. Samsung has had knowledge of the Patents-In-Suit, and its infringement thereof, at least since January 19, 2022 for the '878, '759, and '585 Patents, June 22, 2023 for the '658 Patent, and August 22, 2023 for the '052 Patent, when Plaintiffs provided Samsung notice that it is infringing the Patents-In-Suit. Despite this, Samsung continues without license to make, use, sell, offer to sell, and/or import products and/or services that infringe the Patents-In-Suit, including the Samsung Accused Products, thereby willfully continuing Samsung's infringement.

50. In the interest of providing detailed averments of infringement, the Plaintiffs below demonstrate infringement for one exemplary claim of each of the Patents-In-Suit. However, the exemplary claim and exemplary mapping provided herein should not be considered limiting, and additional claims and mappings will be disclosed per the Court's rules relating to infringement contentions.

COUNT I: INFRINGEMENT OF THE '878 PATENT

51. Plaintiffs incorporate by reference the preceding paragraphs as though fully set forth herein.

52. U.S. Patent No. 10,187,878 ("the '878 Patent") was duly and legally issued on January 22, 2019, for an invention titled, "Method And Apparatus For Improving A Transmission Using A Configured Resource In A Wireless Communication System."

53. Plaintiffs own all rights to the '878 Patent that are necessary to bring this action.

54. Samsung is not currently licensed to practice the '878 Patent.

55. Samsung infringes, contributes to the infringement of, and/or induces infringement of the '878 Patent by making, using, selling, offering for sale, and/or importing the Samsung Accused Products in/into the United States.

56. For example and as shown below, the Samsung Accused Products infringe at least claim 11 of the '878 Patent by virtue of their compatibility with and practice of the 4G and 5G Standards. For example, and to the extent the preamble is limiting, the Samsung Accused Products practice a method of a UE (User Equipment). For example, this functionality is described in the 5G Standard, including but not limited to in 3GPP TS 38.321 sections 4 and 5.

3GPP TS 38.321

4.2 MAC architecture

4.2.1 General

This clause describes a model of the MAC i.e. it does not specify or restrict implementations.

RRC is in control of the MAC configuration.

4.2.2 MAC Entities

The MAC entity of the UE handles the following transport channels:

- Broadcast Channel (BCH);
- Downlink Shared Channel(s) (DL-SCH);
- Paging Channel (PCH);
- Uplink Shared Channel(s) (UL-SCH);
- Random Access Channel(s) (RACH).

5.4.1 UL Grant reception

Uplink grant is either received dynamically on the PDCCH, in a Random Access Response, or configured semi-persistently by RRC. The MAC entity shall have an uplink grant to transmit on the UL-SCH. To perform the requested transmissions, the MAC layer receives HARQ information from lower layers.

57. The Samsung Accused Products further practice the foregoing method under which an uplink grant is available for the UE in a TTI (Transmission Time Interval), wherein the UE does

not have data available for transmission. For example, this functionality is described in the 5G Standard, including but not limited to in 3GPP TS 38.321 section 5 and 3GPP TS 38.306 section 4.

3GPP TS 38.321

5.4.1 UL Grant reception

Uplink grant is either received dynamically on the PDCCH, in a Random Access Response, or configured semi-persistently by RRC. The MAC entity shall have an uplink grant to transmit on the UL-SCH. To perform the requested transmissions, the MAC layer receives HARQ information from lower layers.

3GPP TS 38.306

4.2.6 MAC parameters

Definitions for parameters	Per	M	FDD-TDD DIFF	FR1-FR2 DIFF

….

Definitions for parameters	Per	M	FDD-TDD DIFF	FR1-FR2 DIFF
skipUplinkTxDynamic Indicates whether the UE supports skipping of UL transmission for an uplink grant indicated on PDCCH if no data is available for transmission as specified in TS 38.321 [8].	UE	No	Yes	No

58. The Samsung Accused Products further practice the step whereby the UE transmits a physical control information on a data channel according to the uplink grant if the physical control information needs to be transmitted in the TTI. For example, this functionality is described in the 5G Standard, including but not limited to in 3GPP TS 38.214 sections 5 and 6.

3GPP TS 38.214

5.2.1 Channel state information framework

The time and frequency resources that can be used by the UE to report CSI are controlled by the gNB. CSI may consist of Channel Quality Indicator (CQI), precoding matrix indicator (PMI), CSI-RS resource indicator (CRI), SS/PBCH Block Resource indicator (SSBRI), layer indicator (LI), rank indicator (RI) and/or L1-RSRP.

5.2.3 CSI reporting using PUSCH

A UE shall perform aperiodic CSI reporting using PUSCH on serving cell c upon successful decoding of a DCI format 0_1 which triggers an aperiodic CSI trigger state.

6.1.2.1 Resource allocation in time domain

When the UE is scheduled to transmit a transport block and no CSI report, or the UE is scheduled to transmit a transport block and a CSI report(s) on PUSCH by a DCI, the *Time domain resource assignment* field value m of the DCI provides a row index $m + 1$ to an allocated table. The determination of the used resource allocation table is defined in clause 6.1.2.1.1. The indexed row defines the slot offset K_2, the start and length indicator *SLIV*, or directly the start symbol S and the allocation length L, and the PUSCH mapping type to be applied in the PUSCH transmission.

….

- The slot where the UE shall transmit the PUSCH is determined by K_2 as $\left\lfloor n \cdot \frac{2^{\mu_{PUSCH}}}{2^{\mu_{PDCCH}}} \right\rfloor + K_2$ where n is the slot with the scheduling DCI, K_2 is based on the numerology of PUSCH, and μ_{PUSCH} and μ_{PDCCH} are the subcarrier spacing configurations for PUSCH and PDCCH, respectively, and

59. The Samsung Accused Products further practice the step whereby the UE skips the uplink grant if the physical control information does not need to be transmitted in the TTI. For example, this functionality is described in the 5G Standard, including but not limited to in 3GPP TS 38.306 section 4 and 3GPP TS 38.321 section 5.

3GPP TS 38.306

4.2.6 MAC parameters

Definitions for parameters	Per	M	FDD-TDD DIFF	FR1-FR2 DIFF
….				
skipUplinkTxDynamic Indicates whether the UE supports skipping of UL transmission for an uplink grant indicated on PDCCH if no data is available for transmission as specified in TS 38.321 [8].	UE	No	Yes	No

3GPP TS 38.321

5.4.3.1.3 Allocation of resources

The MAC entity shall not generate a MAC PDU for the HARQ entity if the following conditions are satisfied:

- the MAC entity is configured with *skipUplinkTxDynamic* with value *true* and the grant indicated to the HARQ entity was addressed to a C-RNTI, or the grant indicated to the HARQ entity is a configured uplink grant; and
- there is no aperiodic CSI requested for this PUSCH transmission as specified in TS 38.212 [9]; and
- the MAC PDU includes zero MAC SDUs; and
- the MAC PDU includes only the periodic BSR and there is no data available for any LCG, or the MAC PDU includes only the padding BSR.

60. Accordingly, as illustrated above, the Samsung Accused Products directly infringe one or more claims of the '878 Patent. Samsung makes, uses, sells, offers for sale, and/or imports,

in this District and/or elsewhere in the United States, the Samsung Accused Products and thus directly infringes the '878 Patent.

61. Samsung has also indirectly infringed and continues to indirectly infringe the '878 Patent, as provided in 35 U.S.C. § 271(b), including at least by inducing infringement by others, such as Samsung's customers and end-users, in this District and elsewhere in the United States, to use the Samsung Accused Products in manners that infringe the '878 Patent. For example, Samsung's customers and end-users directly infringe via their use of the Samsung Accused Products to access and use 4G and 5G wireless technologies, infringing the '878 Patent. Samsung induces such direct infringement through its affirmative acts of making, using, selling, offering to sell, and/or importing the Samsung Accused Products, as well as by advertising its 4G and 5G wireless technologies and providing instructions, documentation, and other information to its customers and end-users to encourage and teach them how to use the infringing 4G and 5G wireless technologies, including but not limited to by Samsung providing in-store and online technical support, marketing materials, product manuals, advertisements, and other product documentation. Samsung performs these affirmative acts with knowledge of the '878 Patent and with the intent, or willful blindness, that the induced acts directly infringe the '878 Patent.

62. Samsung has also indirectly infringed and continues to indirectly infringe the '878 Patent, as provided by 35 U.S.C. § 271(c), by contributing to direct infringement committed by others, such as Samsung's customers and end-users, in this District and elsewhere in the United States. Samsung's affirmative acts of selling and offering to sell the Samsung Accused Products in this District and elsewhere in the United States, and causing the Samsung Accused Products to be manufactured, used, sold, and offered for sale, contribute to Samsung's customers and end-users using the Samsung Accused Products, such that the '878 Patent is directly infringed. The accused components in the Samsung Accused Products are material to the inventions claimed in the '878 Patent, are not staple articles or commodities of commerce, have no substantial non-infringing

uses, and are known by Samsung to be especially made or adapted for use in the infringement of the '878 Patent. Samsung performs these affirmative acts with knowledge of the '878 Patent and with the intent, or willful blindness, that they cause direct infringement of the '878 Patent.

63. Samsung has also infringed and continues to infringe the '878 Patent, as provided by 35 U.S.C. § 271(f)(1), by supplying or causing to be supplied in or from the United States all or a substantial portion of the components of the Samsung Accused Products, uncombined in whole or in part, in such a manner as to actively induce their combination outside the United States in a manner that would infringe the '878 Patent if such combination occurred within the United States. Samsung has likewise infringed and continues to infringe the '878 Patent, as provided by 35 U.S.C. § 271(f)(2), by supplying or causing to be supplied in or from the United States components of the Samsung Accused Products that are especially made or especially adapted for infringement of the '878 Patent. The accused components in the Samsung Accused Products are material to the inventions claimed in the '878 Patent, are not staple articles or commodities of commerce, have no substantial non-infringing uses, and are known by Samsung to be especially made or adapted for use in the infringement of the '878 Patent. Samsung performs these affirmative acts with knowledge of the '878 Patent and with the intent, or willful blindness, that they cause direct infringement of the '878 Patent.

64. Samsung's infringement of the '878 Patent has damaged and will continue to damage the Plaintiffs.

65. Samsung has had knowledge of the '878 Patent, and its infringement thereof, at least since January 19, 2022, when Plaintiffs provided Samsung notice that it is infringing the '878 Patent. Samsung continues without license to make, use, sell, offer to sell, and/or import the Samsung Accused Products, willfully continuing Samsung's infringement.

COUNT II: INFRINGEMENT OF THE '052 PATENT

66. Plaintiffs incorporate by reference the preceding paragraphs as though fully set forth herein.

67. U.S. Patent No. 11,291,052 ("the '052 Patent") was duly and legally issued on March 29, 2022, for an invention titled, "Method And Apparatus For Improving Msg3 Transmission Of Random Access Procedure In A Wireless Communication System."

68. Plaintiffs own all rights to the '052 Patent that are necessary to bring this action.

69. Samsung is not currently licensed to practice the '052 Patent.

70. Samsung infringes, contributes to the infringement of, and/or induces infringement of the '052 Patent by making, using, selling, offering for sale, and/or importing the Samsung 5G Accused Products in/into the United States.

71. For example and as shown below, the Samsung 5G Accused Products infringe at least claim 1 of the '052 Patent by virtue of their compatibility with and practice of the 5G Standard. For example, and to the extent the preamble is limiting, the Samsung 5G Accused Products practice a method of a UE (User Equipment) for performing random access procedure. For example, this functionality is described in the 5G Standard, including but not limited to in 3GPP TS 38.300 section 9 and 3GPP TS 38.321 section 5.

<u>3GPP TS 38.300</u>

. . .

<u>3GPP TS 38.321</u>

72. The Samsung 5G Accused Products further practice the step whereby the UE transmits a preamble to a network. For example, this functionality is described in the 5G Standard, including but not limited to in 3GPP TS 38.300 sections 3 and 9 and 3GPP TS 38.321 section 5.

<u>3GPP TS 38.300</u>

3.2 Definitions

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MSG1: preamble transmission of the random access procedure.

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<u>3GPP TS 38.321</u>

73. The Samsung 5G Accused Products further practice the step whereby the UE receives a Msg2 containing a TTI (Transmission Timer Interval) information of a Msg3, associated with uplink, from the network in response to the preamble. For example, this functionality is described in the 5G Standard, including but not limited to in 3GPP TS 3GPP TS 38.300 sections 3, 7, and 9, 3GPP TS 38.213 section 8, and 3GPP TS 38.321 sections 5 and 6.

<u>3GPP TS 38.300</u>

3.2 Definitions

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7.3.2 Scheduling

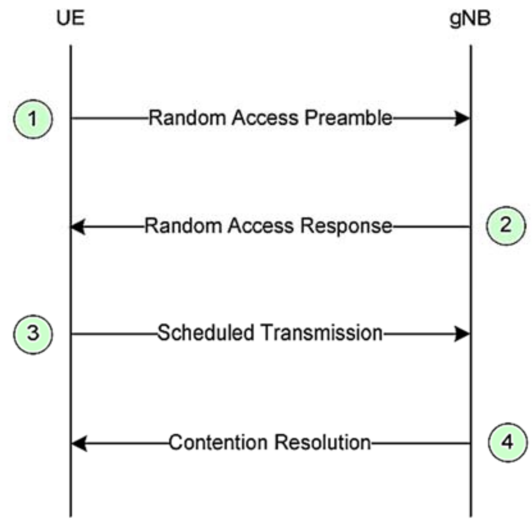
The MIB is mapped on the BCCH and carried on BCH while all other SI messages are mapped on the BCCH, where they are dynamically carried on DL-SCH. The scheduling of SI messages part of Other SI is indicated by *SIB1*.

For UEs in RRC_IDLE and RRC_INACTIVE, a request for Other SI triggers a random access procedure (see clause 9.2.6) where MSG3 includes the SI request message unless the requested SI is associated to a subset of the PRACH resources, in which case MSG1 is used for indication of the requested Other SI. When MSG1 is used, the minimum granularity of the request is one SI message (i.e. a set of SIBs), one RACH preamble and/or PRACH resource can be used to request multiple SI messages and the gNB acknowledges the request in MSG2. When MSG 3 is used, the gNB acknowledges the request in MSG4.

. . .

9.2.6 Random Access Procedure

. . .



(a) Contention-Based

<u>3GPP TS 38.213</u>

8 Random access procedure

. . .

From the physical layer perspective, the L1 random access procedure includes the transmission of random access preamble (Msg1) in a PRACH, random access response (RAR) message with a PDCCH/PDSCH (Msg2), and when applicable, the transmission of a PUSCH scheduled by a RAR UL grant, and PDSCH for contention resolution.

<u>3GPP TS 38.321</u>

5.1.4 Random Access Response reception

Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the MAC entity shall:

. . .

2> if the Random Access Response contains a MAC subPDU with Random Access Preamble identifier corresponding to the transmitted *PREAMBLE_INDEX* (see clause 5.1.3):

3> consider this Random Access Response reception successful.

2> if the Random Access Response reception is considered successful:

3> if the Random Access Response includes a MAC subPDU with RAPID only:

. . .

6> process the received UL grant value and indicate it to the lower layers.

. . .

6.2.3 MAC payload for Random Access Response

. . .

- UL Grant: The Uplink Grant field indicates the resources to be used on the uplink in TS 38.213 [6]. The size of the UL Grant field is 27 bits;

. . .

R	Timing Advance Command	Oct 1
Timing Advance Command	UL Grant	Oct 2
UL Grant		Oct 3
UL Grant		Oct 4
UL Grant		Oct 5

74. The Samsung 5G Accused Products practice the foregoing step wherein the TTI information, contained in the Msg2, of the Msg3, associated with uplink, includes a TTI duration of the Msg3, associated with uplink, and a start timing offset of the Msg3, associated with uplink. For example, this functionality is described in the 5G Standard, including but not limited to in 3GPP TS 38.213 section 8, 3GPP TS 38.214 section 6, and 3GPP TS 38.331 section 6.

<u>3GPP TS 38.213</u>

8.2 Random access response

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A RAR UL grant schedules a PUSCH transmission from the UE. The contents of the RAR UL grant, starting with the MSB and ending with the LSB, are given in Table 8.2-1.

. . .

Table 8.2-1: Random Access Response Grant Content field size

RAR grant field	Number of bits
Frequency hopping flag	1
PUSCH frequency resource allocation	14
PUSCH time resource allocation	4
MCS	4
TPC command for PUSCH	3
CSI request	1

. . .

8.3 PUSCH scheduled by RAR UL grant

. . .

A UE transmits a transport block in a PUSCH scheduled by a RAR UL grant in a corresponding RAR message using redundancy version number 0. If a TC-RNTI is provided by higher layers, the scrambling initialization of the PUSCH corresponding to the RAR UL grant in clause 8.2 is by TC-RNTI. Otherwise, the scrambling initialization of the PUSCH corresponding to the RAR UL grant in clause 8.2 is by C-RNTI. Msg3 PUSCH retransmissions, if any, of the transport block, are scheduled by a DCI format 0_0 with CRC scrambled by a TC-RNTI provided in the corresponding RAR message [11, TS 38.321]. The UE always transmits the PUSCH scheduled by a RAR UL grant without repetitions.

With reference to slots for a PUSCH transmission scheduled by a RAR UL grant, if a UE receives a PDSCH with a RAR message ending in slot n for a corresponding PRACH transmission from the UE, the UE transmits the PUSCH in slot $n+k_2+\Delta$, where k_2 and Δ are provided in [6, TS 38.214].

The UE may assume a minimum time between the last symbol of a PDSCH reception conveying a RAR message with a RAR UL grant and the first symbol of a corresponding PUSCH transmission scheduled by the RAR UL grant is equal to $N_{T,1}+N_{T,2}+0.5$ msec, where $N_{T,1}$ is a time duration of N_1 symbols corresponding to a PDSCH processing time for UE processing capability 1 when additional PDSCH DM-RS is configured, $N_{T,2}$ is a time duration of N_2 symbols corresponding to a PUSCH preparation time for UE processing capability 1 [6, TS 38.214] and, for determining the minimum time, the UE considers that N_1 and N_2 correspond to the smaller of the SCS configurations for the PDSCH and the PUSCH. For $\mu=0$, the UE assumes $N_{1,0}=14$ [6, TS 38.214].

<u>3GPP TS 38.214</u>

6.1.2 Resource allocation

6.1.2.1 Resource allocation in time domain

When the UE is scheduled to transmit a transport block and no CSI report, or the UE is scheduled to transmit a transport block and a CSI report(s) on PUSCH by a DCI, the *Time domain resource assignment* field value *m* of the DCI provides a row index *m* + 1 to an allocated table. The determination of the used resource allocation table is defined in Clause 6.1.2.1.1. The indexed row defines the slot offset K_2, the start and length indicator *SLIV*, or directly the start symbol *S* and the allocation length *L*, and the PUSCH mapping type to be applied in the PUSCH transmission.

When the UE is scheduled to transmit a PUSCH with no transport block and with a CSI report(s) by a *CSI request* field on a DCI, the *Time domain resource assignment* field value *m* of the DCI provides a row index *m* + 1 to an allocated table which is defined by the higher layer configured *pusch-TimeDomainAllocationList* in *pusch-Config*. The indexed row defines the start and length indicator SLIV, and the PUSCH mapping type to be applied in the PUSCH transmission and the K_2 value is determined as $K_2=\max_j Y_j(m+1)$, where $Y_j, j=0,\ldots,N_{Rep}-1$ are the corresponding list entries of the higher layer parameter *reportSlotOffsetList* in *CSI-ReportConfig* for the N_{Rep} triggered CSI Reporting Settings and $Y_j(m+1)$ is the *(m+1)*th entry of Y_j.

- The slot where the UE shall transmit the PUSCH is determined by K_2 as $\left\lfloor n\cdot\frac{2^{\mu_{PUSCH}}}{2^{\mu_{PDCCH}}}\right\rfloor+K_2$ where *n* is the slot with the scheduling DCI, K_2 is based on the numerology of PUSCH, and μ_{PUSCH} and μ_{PDCCH} are the subcarrier spacing configurations for PUSCH and PDCCH, respectively, and

- The starting symbol S relative to the start of the slot, and the number of consecutive symbols L counting from the symbol S allocated for the PUSCH are determined from the start and length indicator $SLIV$ of the indexed row:

  if $(L-1)\leq 7$ then

  $$SLIV = 14\cdot(L-1)+S$$

  else

  $$SLIV = 14\cdot(14-L+1)+(14-1-S)$$

  where $0 < L \leq 14-S$, and

- The PUSCH mapping type is set to Type A or Type B as defined in Clause 6.4.1.1.3 of [4, TS 38.211] as given by the indexed row.

The UE shall consider the S and L combinations defined in table 6.1.2.1-1 as valid PUSCH allocations

Table 6.1.2.1-1: Valid *S* and *L* combinations

PUSCH mapping type	Normal cyclic prefix			Extended cyclic prefix		
	S	***L***	***S+L***	***S***	***L***	***S+L***
Type A	0	{4,…,14}	{4,…,14}	0	{4,…,12}	{4,…,12}
Type B	{0,…,13}	{1,…,14}	{1,…,14}	{0,…, 11}	{1,…,12}	{1,…,12}

When transmitting PUSCH scheduled by DCI format 0_1 in PDCCH with CRC scrambled with C-RNTI, MCS-C-RNTI, or CS-RNTI with NDI=1, if the UE is configured with *pusch-AggregationFactor*, the same symbol allocation is applied across the *pusch-AggregationFactor* consecutive slots and the PUSCH is limited to a single transmission layer. The UE shall repeat the TB across the *pusch-AggregationFactor* consecutive slots applying the same symbol allocation in each slot. The redundancy version to be applied on the nth transmission occasion of the TB, where n = 0, 1, …*pusch-AggregationFactor* -1, is determined according to table 6.1.2.1-2.

Table 6.1.2.1-2: Redundancy version when *pusch-AggregationFactor* is present

rv_{id} indicated by the DCI scheduling the PUSCH	rv_{id} to be applied to n^{th} transmission occasion			
	n mod 4 = 0	*n* mod 4 = 1	*n* mod 4 = 2	*n* mod 4 = 3
0	0	2	3	1
2	2	3	1	0
3	3	1	0	2
1	1	0	2	3

A PUSCH transmission in a slot of a multi-slot PUSCH transmission is omitted according to the conditions in Clause 11.1 of [6, TS38.213].

6.1.2.1.1 Determination of the resource allocation table to be used for PUSCH

Table 6.1.2.1.1-1 defines which PUSCH time domain resource allocation configuration to apply. Either a default PUSCH time domain allocation A according to table 6.1.2.1.1-2, is applied, or the higher layer configured *pusch-TimeDomainAllocationList* in either *pusch-ConfigCommon* or *pusch-Config* is applied.

Table 6.1.2.1.1-4 defines the subcarrier spacing specific values j. j is used in determination of K_2 in conjunction to table 6.1.2.1.1-2, for normal CP or table 6.1.2.1.1.-3 for extended CP, where μ_{PUSCH} is the subcarrier spacing configurations for PUSCH.

Table 6.1.2.1.1-5 defines the additional subcarrier spacing specific slot delay value for the first transmission of PUSCH scheduled by the RAR. When the UE transmits a PUSCH scheduled by RAR, the Δ value specific to the PUSCH subcarrier spacing μ_{PUSCH} is applied in addition to the K_2 value.

Table 6.1.2.1.1-1: Applicable PUSCH time domain resource allocation

RNTI	PDCCH search space	*pusch-ConfigCommon* includes *pusch-TimeDomainAllocationList*	*pusch-Config* includes *pusch-TimeDomainAllocationList*	PUSCH time domain resource allocation to apply
PUSCH scheduled by MAC RAR as described in clause 8.2 of [6, TS 38.213]		No	-	Default A
		Yes		*pusch-TimeDomainAllocationList* provided in *pusch-ConfigCommon*
C-RNTI, MCS-C-RNTI, TC-RNTI, CS-RNTI	Any common search space associated with CORESET 0	No	-	Default A
		Yes		*pusch-AlloTimeDomaincationList* provided in *pusch-ConfigCommon*
C-RNTI, MCS-C-RNTI, TC-RNTI, CS-RNTI, SP-CSI-RNTI	Any common search space not associated with CORESET 0, UE specific search space	No	No	Default A
		Yes	No	*pusch-TimeDomainAllocationList* provided in *pusch-ConfigCommon*
		No/Yes	Yes	*pusch-TimeDomainAllocationList* provided in *pusch-Config*

Table 6.1.2.1.1-2: Default PUSCH time domain resource allocation A for normal CP

Row index	PUSCH mapping type	K_2	*S*	*L*
1	Type A	j	0	14
2	Type A	j	0	12
3	Type A	j	0	10
4	Type B	j	2	10
5	Type B	j	4	10
6	Type B	j	4	8
7	Type B	j	4	6
8	Type A	j+1	0	14
9	Type A	j+1	0	12
10	Type A	j+1	0	10
11	Type A	j+2	0	14
12	Type A	j+2	0	12
13	Type A	j+2	0	10
14	Type B	j	8	6
15	Type A	j+3	0	14
16	Type A	j+3	0	10

Table 6.1.2.1.1-3: Default PUSCH time domain resource allocation A for extended CP

Row index	PUSCH mapping type	K_2	S	L
1	Type A	j	0	8
2	Type A	j	0	12
3	Type A	j	0	10
4	Type B	j	2	10
5	Type B	j	4	4
6	Type B	j	4	8
7	Type B	j	4	6
8	Type A	j+1	0	8
9	Type A	j+1	0	12
10	Type A	j+1	0	10
11	Type A	j+2	0	6
12	Type A	j+2	0	12
13	Type A	j+2	0	10
14	Type B	j	8	4
15	Type A	j+3	0	8
16	Type A	j+3	0	10

Table 6.1.2.1.1-4: Definition of value j

μ_{PUSCH}	j
0	1
1	1
2	2
3	3

Table 6.1.2.1.1-5: Definition of value Δ

μ_{PUSCH}	Δ
0	2
1	3
2	4
3	6

3GPP TS 38.331

6.2.2 Message definitions

. . .

– *SIB1*

SIB1 contains information relevant when evaluating if a UE is allowed to access a cell and defines the scheduling of other system information. It also contains radio resource configuration information that is common for all UEs and barring information applied to the unified access control.

Signalling radio bearer: N/A

RLC-SAP: TM

Logical channels: BCCH

Direction: Network to UE

. . .

***SIB1* message**

```
-- ASN1START
-- TAG-SIB1-START

SIB1 ::=          SEQUENCE {
```

. . .

```
    cellAccessRelatedInfo           CellAccessRelatedInfo,
    connEstFailureControl           ConnEstFailureControl                                    OPTIONAL,   -- Need R
    si-SchedulingInfo               SI-SchedulingInfo                                        OPTIONAL,   -- Need R
    servingCellConfigCommon         ServingCellConfigCommonSIB                               OPTIONAL,   -- Need R
    ims-EmergencySupport            ENUMERATED {true}                                        OPTIONAL,   -- Need R
    eCallOverIMS-Support            ENUMERATED {true}                                        OPTIONAL,   -- Cond Absent
```

. . .

***ServingCellConfigCommonSIB* information element**

```
-- ASN1START
-- TAG-SERVINGCELLCONFIGCOMMONSIB-START

ServingCellConfigCommonSIB ::=        SEQUENCE {
    downlinkConfigCommon                  DownlinkConfigCommonSIB,
    uplinkConfigCommon                    UplinkConfigCommonSIB                        OPTIONAL, -- Need R
```

. . .

– *UplinkConfigCommonSIB*

The IE *UplinkConfigCommonSIB* provides common uplink parameters of a cell.

***UplinkConfigCommonSIB* information element**

```
-- ASN1START
-- TAG-UPLINKCONFIGCOMMONSIB-START

UplinkConfigCommonSIB ::=             SEQUENCE {
    frequencyInfoUL                       FrequencyInfoUL-SIB,
    initialUplinkBWP                      BWP-UplinkCommon,
```

. . .

***BWP-UplinkCommon* information element**

```
-- ASN1START
-- TAG-BWP-UPLINKCOMMON-START

BWP-UplinkCommon ::=                  SEQUENCE {
    genericParameters                     BWP,
    rach-ConfigCommon                     SetupRelease { RACH-ConfigCommon }         OPTIONAL,   -- Need M
    pusch-ConfigCommon                    SetupRelease { PUSCH-ConfigCommon }        OPTIONAL,   -- Need M
    pucch-ConfigCommon                    SetupRelease { PUCCH-ConfigCommon }        OPTIONAL,   -- Need M
    ...
}
```

. . .

6.3.2 Radio resource control information elements

. . .

***PUSCH-ConfigCommon* information element**

```
-- ASN1START
-- TAG-PUSCH-CONFIGCOMMON-START

PUSCH-ConfigCommon ::=                SEQUENCE {
    groupHoppingEnabledTransformPrecoding   ENUMERATED {enabled}                   OPTIONAL,   -- Need R
    pusch-TimeDomainAllocationList          PUSCH-TimeDomainResourceAllocationList OPTIONAL,   -- Need R
    msg3-DeltaPreamble                      INTEGER (-1..6)                        OPTIONAL,   -- Need R
```

. . .

***PUSCH-TimeDomainResourceAllocation* information element**

```
-- ASN1START
-- TAG-PUSCH-TIMEDOMAINRESOURCEALLOCATIONLIST-START

PUSCH-TimeDomainResourceAllocationList ::=  SEQUENCE (SIZE(1..maxNrofUL-Allocations)) OF PUSCH-TimeDomainResourceAllocation

PUSCH-TimeDomainResourceAllocation ::=  SEQUENCE {
    k2                                      INTEGER(0..32)          OPTIONAL,    -- Need S
    mappingType                             ENUMERATED {typeA, typeB},
    startSymbolAndLength                    INTEGER (0..127)
}

-- TAG-PUSCH-TIMEDOMAINRESOURCEALLOCATIONLIST-STOP
-- ASN1STOP
```

***PUSCH-TimeDomainResourceAllocationList* field descriptions**
k2 Corresponds to L1 parameter 'K2' (see TS 38.214 [19], clause 6.1.2.1) When the field is absent the UE applies the value 1 when PUSCH SCS is 15/30 kHz; the value 2 when PUSCH SCS is 60 kHz, and the value 3 when PUSCH SCS is 120KHz.
mappingType Mapping type (see TS 38.214 [19], clause 6.1.2.1).
startSymbolAndLength An index giving valid combinations of start symbol and length (jointly encoded) as start and length indicator (SLIV). The network configures the field so that the allocation does not cross the slot boundary. (see TS 38.214 [19], clause 6.1.2.1).

. . .

6.4 RRC multiplicity and type constraint values

– Multiplicity and type constraint definitions

. . .

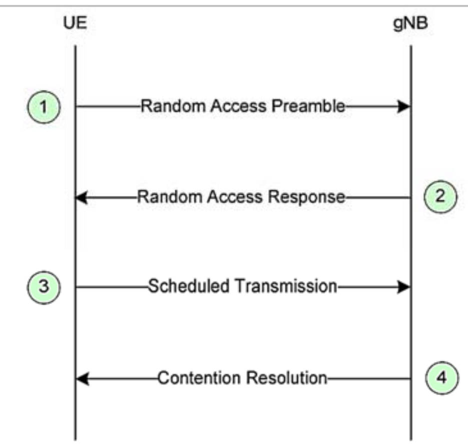
```
maxNrofUL-Allocations                   INTEGER ::= 16      -- Maximum number of PUSCH time domain resource allocations.
maxQFI                                  INTEGER ::= 63
```

75. The Samsung 5G Accused Products further practice the step whereby the UE performs a single (TB) transport block of Msg3 transmission to the network according to the TTI information of the Msg3. For example, this functionality is described in the 5G Standard, including but not limited to in 3GPP TS 38.300 section 9, 3GPP TS 38.213 section 8, and 3GPP TS 38.321 section 5.

<u>3GPP TS 38.300</u>

9.2.6 Random Access Procedure

. . .



(a) Contention-Based

<u>3GPP TS 38.213</u>

8.3 PUSCH scheduled by RAR UL grant

. . .

A UE transmits a transport block in a PUSCH scheduled by a RAR UL grant in a corresponding RAR message using redundancy version number 0. If a TC-RNTI is provided by higher layers, the scrambling initialization of the PUSCH corresponding to the RAR UL grant in clause 8.2 is by TC-RNTI. Otherwise, the scrambling initialization of the PUSCH corresponding to the RAR UL grant in clause 8.2 is by C-RNTI. Msg3 PUSCH retransmissions, if any, of the transport block, are scheduled by a DCI format 0_0 with CRC scrambled by a TC-RNTI provided in the corresponding RAR message [11, TS 38.321]. The UE always transmits the PUSCH scheduled by a RAR UL grant without repetitions.

With reference to slots for a PUSCH transmission scheduled by a RAR UL grant, if a UE receives a PDSCH with a RAR message ending in slot n for a corresponding PRACH transmission from the UE, the UE transmits the PUSCH in slot $n+k_2+\Delta$, where k_2 and Δ are provided in [6, TS 38.214].

The UE may assume a minimum time between the last symbol of a PDSCH reception conveying a RAR message with a RAR UL grant and the first symbol of a corresponding PUSCH transmission scheduled by the RAR UL grant is equal to $N_{T,1}+N_{T,2}+0.5$ msec, where $N_{T,1}$ is a time duration of N_1 symbols corresponding to a PDSCH processing time for UE processing capability 1 when additional PDSCH DM-RS is configured, $N_{T,2}$ is a time duration of N_2 symbols corresponding to a PUSCH preparation time for UE processing capability 1 [6, TS 38.214] and, for determining the minimum time, the UE considers that N_1 and N_2 correspond to the smaller of the SCS configurations for the PDSCH and the PUSCH. For $\mu=0$, the UE assumes $N_{1,0}=14$ [6, TS 38.214].

3GPP TS 38.321

5.1.4 Random Access Response reception

. . .

5> if this is the first successfully received Random Access Response within this Random Access procedure:

…

6> obtain the MAC PDU to transmit from the Multiplexing and assembly entity and store it in the Msg3 buffer.

…

5.4 UL-SCH data transfer

. . .

5.4.2.1 HARQ Entity

. . .

For each uplink grant, the HARQ entity shall:

…

2> if the uplink grant was received in a Random Access Response; or

…

3> if there is a MAC PDU in the Msg3 buffer and the uplink grant was received in a Random Access Response; or:

…

4> obtain the MAC PDU to transmit from the Msg3 buffer.

…

3> if a MAC PDU to transmit has been obtained:

4> deliver the MAC PDU and the uplink grant and the HARQ information of the TB to the identified HARQ process;

4> instruct the identified HARQ process to trigger a new transmission;

76. Accordingly, as illustrated above, the Samsung 5G Accused Products directly infringe one or more claims of the '052 Patent. Samsung makes, uses, sells, offers for sale, and/or imports, in this District and/or elsewhere in the United States, the Samsung 5G Accused Products and thus directly infringes the '052 Patent.

77. Samsung has also indirectly infringed and continues to indirectly infringe the '052 Patent, as provided in 35 U.S.C. § 271(b), including at least by inducing infringement by others, such as Samsung's customers and end-users, in this District and elsewhere in the United States, to use the Samsung 5G Accused Products in manners that infringe the '052 Patent. For example, Samsung's customers and end-users directly infringe via their use of the Samsung 5G Accused

Products to access and use 5G wireless technologies, infringing the '052 Patent. Samsung induces such direct infringement through its affirmative acts of making, using, selling, offering to sell, and/or importing the Samsung 5G Accused Products, as well as by advertising its 5G wireless technologies and providing instructions, documentation, and other information to its customers and end-users to encourage and teach them how to use the infringing 5G wireless technologies, including but not limited to by Samsung providing in-store and online technical support, marketing materials, product manuals, advertisements, and other product documentation. Samsung performs these affirmative acts with knowledge of the '052 Patent and with the intent, or willful blindness, that the induced acts directly infringe the '052 Patent.

78. Samsung has also indirectly infringed and continues to indirectly infringe the '052 Patent, as provided by 35 U.S.C. § 271(c), by contributing to direct infringement committed by others, such as Samsung's customers and end-users, in this District and elsewhere in the United States. Samsung's affirmative acts of selling and offering to sell the Samsung 5G Accused Products in this District and elsewhere in the United States, and causing the Samsung 5G Accused Products to be manufactured, used, sold, and offered for sale, contribute to Samsung's customers and end-users using the Samsung 5G Accused Products, such that the '052 Patent is directly infringed. The accused components in the Samsung 5G Accused Products are material to the inventions claimed in the '052 Patent, are not staple articles or commodities of commerce, have no substantial non-infringing uses, and are known by Samsung to be especially made or adapted for use in the infringement of the '052 Patent. Samsung performs these affirmative acts with knowledge of the '052 Patent and with the intent, or willful blindness, that they cause direct infringement of the '052 Patent.

79. Samsung has also infringed and continues to infringe the '052 Patent, as provided by 35 U.S.C. § 271(f)(1), by supplying or causing to be supplied in or from the United States all or a substantial portion of the components of the Samsung 5G Accused Products, uncombined in

whole or in part, in such a manner as to actively induce their combination outside the United States in a manner that would infringe the '052 Patent if such combination occurred within the United States. Samsung has likewise infringed and continues to infringe the '052 Patent, as provided by 35 U.S.C. § 271(f)(2), by supplying or causing to be supplied in or from the United States components of the Samsung 5G Accused Products that are especially made or especially adapted for infringement of the '052 Patent. The accused components in the Samsung 5G Accused Products are material to the inventions claimed in the '052 Patent, are not staple articles or commodities of commerce, have no substantial non-infringing uses, and are known by Samsung to be especially made or adapted for use in the infringement of the '052 Patent. Samsung performs these affirmative acts with knowledge of the '052 Patent and with the intent, or willful blindness, that they cause direct infringement of the '052 Patent.

80. Samsung's infringement of the '052 Patent has damaged and will continue to damage the Plaintiffs.

81. Samsung has had knowledge of the '052 Patent, and its infringement thereof, at least since August 22, 2023, when Plaintiffs provided Samsung notice that it is infringing the '052 Patent. Samsung continues without license to make, use, sell, offer to sell, and/or import the Samsung 5G Accused Products, willfully continuing Samsung's infringement.

COUNT III: INFRINGEMENT OF THE '658 PATENT

82. Plaintiffs incorporate by reference the preceding paragraphs as though fully set forth herein.

83. U.S. Patent No. 10,104,658 ("the '658 Patent") was duly and legally issued on October 16, 2018, for an invention titled, "Method And Apparatus For Delivery Of Control Signaling In A Wireless Communication System."

84. Plaintiffs own all rights to the '658 Patent that are necessary to bring this action.

85. Samsung is not currently licensed to practice the '658 Patent.

86. Samsung infringes, contributes to the infringement of, and/or induces infringement of the '658 Patent by making, using, selling, offering for sale, and/or importing the Samsung 5G Accused Products in/into the United States.

87. For example and as shown below, the Samsung 5G Accused Products infringe at least claim 11 of the '658 Patent by virtue of their compatibility with and practice of the 5G Standard. For example, and to the extent the preamble is limiting, the Samsung 5G Accused Products practice a method for a User Equipment (UE). For example, this functionality is described in the 5G Standard, including but not limited to in 3GPP TS 38.213 section 10.

3GPP TS 38.213

10.1 UE procedure for determining physical downlink control channel assignment

A set of PDCCH candidates for a UE to monitor is defined in terms of PDCCH search space sets. A search space set can be a CSS set or a USS set. A UE monitors PDCCH candidates in one or more of the following search spaces sets

88. The Samsung 5G Accused Products further practice the step of communicating with a network node in a cell via downlink and uplink transmissions, wherein the downlink and uplink transmissions are organized into radio frames, each radio frame includes multiple subframes, and each subframe includes multiple symbols. For example, this functionality is described in the 5G Standard, including but not limited to in 3GPP TS 38.211 sections 4, 6 and 7.

3GPP TS 38.211

4.2 Numerologies

Multiple OFDM numerologies are supported as given by Table 4.2-1 where μ and the cyclic prefix for a bandwidth part are obtained from the higher-layer parameter *subcarrierSpacing* and *cyclicPrefix*, respectively.

Table 4.2-1: Supported transmission numerologies.

μ	$\Delta f = 2^{\mu} \cdot 15\,[\text{kHz}]$	**Cyclic prefix**
0	15	Normal
1	30	Normal
2	60	Normal, Extended
3	120	Normal
4	240	Normal

. . .

4.3.1 Frames and subframes

Downlink and uplink transmissions are organized into frames with $T_f = (\Delta f_{max} N_f / 100) \cdot T_c = 10\,\text{ms}$ duration, each consisting of ten subframes of $T_{sf} = (\Delta f_{max} N_f / 1000) \cdot T_c = 1\,\text{ms}$ duration. The number of consecutive OFDM symbols per subframe is $N_{symb}^{subframe,\mu} = N_{symb}^{slot} N_{slot}^{subframe,\mu}$. Each frame is divided into two equally-sized half-frames of five subframes each with half-frame 0 consisting of subframes 0 – 4 and half-frame 1 consisting of subframes 5 – 9.

There is one set of frames in the uplink and one set of frames in the downlink on a carrier.

Uplink frame number i for transmission from the UE shall start $T_{TA} = (N_{TA} + N_{TA,offset}) T_c$ before the start of the corresponding downlink frame at the UE where $N_{TA,offset}$ is given by [5, TS 38.213].

. . .

4.3.2 Slots

For subcarrier spacing configuration μ, slots are numbered $n_s^\mu \in \{0, \ldots, N_{slot}^{subframe,\mu} - 1\}$ in increasing order within a subframe and $n_{s,f}^\mu \in \{0, \ldots, N_{slot}^{frame,\mu} - 1\}$ in increasing order within a frame. There are N_{symb}^{slot} consecutive OFDM symbols in a slot where N_{symb}^{slot} depends on the cyclic prefix as given by Tables 4.3.2-1 and 4.3.2-2. The start of slot n_s^μ in a subframe is aligned in time with the start of OFDM symbol $n_s^\mu N_{symb}^{slot}$ in the same subframe.

. . .

Table 4.3.2-1: Number of OFDM symbols per slot, slots per frame, and slots per subframe for normal cyclic prefix.

μ	N_{symb}^{slot}	$N_{slot}^{frame,\mu}$	$N_{slot}^{subframe,\mu}$
0	14	10	1
1	14	20	2
2	14	40	4
3	14	80	8
4	14	160	16

Table 4.3.2-2: Number of OFDM symbols per slot, slots per frame, and slots per subframe for extended cyclic prefix.

μ	N_{symb}^{slot}	$N_{slot}^{frame,\mu}$	$N_{slot}^{subframe,\mu}$
2	12	40	4

. . .

6 Uplink

6.1 Overview

6.1.1 Overview of physical channels

An uplink physical channel corresponds to a set of resource elements carrying information originating from higher layers. The following uplink physical channels are defined:

- Physical Uplink Shared Channel, PUSCH
- Physical Uplink Control Channel, PUCCH
- Physical Random Access Channel, PRACH

. . .

7 Downlink

7.1 Overview

7.1.1 Overview of physical channels

A downlink physical channel corresponds to a set of resource elements carrying information originating from higher layers. The following downlink physical channels are defined:

- Physical Downlink Shared Channel, PDSCH
- Physical Broadcast Channel, PBCH
- Physical Downlink Control Channel, PDCCH.

89. The Samsung 5G Accused Products further practice the step of monitoring, in the cell, a UE specific signal in at least one first symbol of a downlink control region of a subframe. For example, this functionality is described in the 5G Standard, including but not limited to in 3GPP TS 38.213 sections 3 and 10 and 3GPP TS 38.331 section 6.

<u>3GPP TS 38.213</u>

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in [1, TR 21.905].

. . .

BWP	Bandwidth part

…

CORESET	Control resource set

…

DL	Downlink

…

USS	UE-specific search space

. . .

10 UE procedure for receiving control information

…

A UE monitors a set of PDCCH candidates in one or more CORESETs on the active DL BWP on each activated serving cell configured with PDCCH monitoring according to corresponding search space sets where monitoring implies decoding each PDCCH candidate according to the monitored DCI formats.

…

10.1 UE procedure for determining physical downlink control channel assignment

A set of PDCCH candidates for a UE to monitor is defined in terms of PDCCH search space sets. A search space set can be a CSS set or a USS set. A UE monitors PDCCH candidates in one or more of the following search spaces sets

. . .

- a USS set configured by *SearchSpace* in *PDCCH-Config* with *searchSpaceType* = *ue-Specific* for DCI formats with CRC scrambled by C-RNTI, MCS-C-RNTI, SP-CSI-RNTI, or CS-RNTI(s).

. . .

For each DL BWP configured to a UE in a serving cell, a UE can be provided by higher layer signalling with $P \leq 3$ CORESETs. For each CORESET, the UE is provided the following by *ControlResourceSet*:

- a CORESET index p, $0 < p < 12$, by *controlResourceSetId*;
- a DM-RS scrambling sequence initialization value by *pdcch-DMRS-ScramblingID*;
- a precoder granularity for a number of REGs in the frequency domain where the UE can assume use of a same DM-RS precoder by *precoderGranularity*;
- a number of consecutive symbols provided by *duration*;

<u>3GPP TS 38.331</u>

6.3.2 Radio resource control information elements

. . .

***ControlResourceSet* information element**

```
-- ASN1START
-- TAG-CONTROLRESOURCESET-START

ControlResourceSet ::=              SEQUENCE {
    controlResourceSetId                ControlResourceSetId,

    frequencyDomainResources            BIT STRING (SIZE (45)),
    duration                            INTEGER (1..maxCoReSetDuration),
    cce-REG-MappingType                 CHOICE {
        interleaved                         SEQUENCE {
            reg-BundleSize                      ENUMERATED {n2, n3, n6},
            interleaverSize                     ENUMERATED {n2, n3, n6},
            shiftIndex                          INTEGER(0..maxNrofPhysicalResourceBlocks-1)       OPTIONAL -- Need S
        },
        nonInterleaved                      NULL
    },
    precoderGranularity                 ENUMERATED {sameAsREG-bundle, allContiguousRBs},
    tci-StatesPDCCH-ToAddList           SEQUENCE(SIZE (1..maxNrofTCI-StatesPDCCH)) OF TCI-StateId OPTIONAL, -- Cond NotSIB1-initialBWP
    tci-StatesPDCCH-ToReleaseList       SEQUENCE(SIZE (1..maxNrofTCI-StatesPDCCH)) OF TCI-StateId OPTIONAL, -- Cond NotSIB1-initialBWP
    tci-PresentInDCI                        ENUMERATED {enabled}                              OPTIONAL, -- Need S
    pdcch-DMRS-ScramblingID                 INTEGER (0..65535)                                OPTIONAL, -- Need S
    ...
}

-- TAG-CONTROLRESOURCESET-STOP
-- ASN1STOP
```

***ControlResourceSet* field descriptions**
cce-REG-MappingType Mapping of Control Channel Elements (CCE) to Resource Element Groups (REG) (see TS 38.211 [16], clauses 7.3.2.2 and 7.4.1.3.2).
controlResourceSetId Value 0 identifies the common CORESET configured in *MIB* and in *ServingCellConfigCommon* (*controlResourceSetZero*) and is hence not used here in the *ControlResourceSet* IE. Values 1..*maxNrofControlResourceSets-1* identify CORESETs configured by dedicated signalling or in *SIB1*. The *controlResourceSetId* is unique among the BWPs of a serving cell.
duration Contiguous time duration of the CORESET in number of symbols (see TS 38.211 [16], clause 7.3.2.2).
frequencyDomainResources Frequency domain resources for the CORESET. Each bit corresponds a group of 6 RBs, with grouping starting from the first RB group (see TS 38.213 [13], clause 10.1) in the BWP. The first (left-most / most significant) bit corresponds to the first RB group in the BWP, and so on. A bit that is set to 1 indicates that this RB group belongs to the frequency domain resource of this CORESET. Bits corresponding to a group of RBs not fully contained in the bandwidth part within which the CORESET is configured are set to zero (see TS 38.211 [16], clause 7.3.2.2).
interleaverSize Interleaver-size (see TS 38.211 [16], clause 7.3.2.2).
pdcch-DMRS-ScramblingID PDCCH DMRS scrambling initialization (see TS 38.211 [16], clause 7.4.1.3.1). When the field is absent the UE applies the value of the *physCellId* configured for this serving cell.
precoderGranularity Precoder granularity in frequency domain (see TS 38.211 [16], clauses 7.3.2.2 and 7.4.1.3.2).
reg-BundleSize Resource Element Groups (REGs) can be bundled to create REG bundles. This parameter defines the size of such bundles (see TS 38.211 [16], clause 7.3.2.2).
shiftIndex When the field is absent the UE applies the value of the *physCellId*configured for this serving cell (see TS 38.211 [16], clause 7.3.2.2).
tci-PresentInDCI This field indicates if TCI field is present or absent in DL-related DCI. When the field is absent the UE considers the TCI to be absent/disabled. In case of cross carrier scheduling, the network sets this field to enabled for the *ControlResourceSet* used for cross carrier scheduling in the scheduling cell (see TS 38.214 [19], clause 5.1.5).
tci-StatesPDCCH-ToAddList A subset of the TCI states defined in pdsch-Config included in the *BWP-DownlinkDedicated* corresponding to the serving cell and to the DL BWP to which the *ControlResourceSet* belong to. They are used for providing QCL relationships between the DL RS(s) in one RS Set (TCI-State) and the PDCCH DMRS ports (see TS 38.213 [13], clause 6.). The network configures at most *maxNrofTCI-StatesPDCCH* entries.

. . .

– *PDCCH-Config*

The IE *PDCCH-Config* is used to configure UE specific PDCCH parameters such as control resource sets (CORESET), search spaces and additional parameters for acquiring the PDCCH. If this IE is used for the scheduled cell in case of cross carrier scheduling, the fields other than *searchSpacesToAddModList* and *searchSpacesToReleaseList* are absent.

***PDCCH-Config* information element**

```
-- ASN1START
-- TAG-PDCCH-CONFIG-START

PDCCH-Config ::=                    SEQUENCE {
    controlResourceSetToAddModList      SEQUENCE(SIZE (1..3)) OF ControlResourceSet           OPTIONAL,   -- Need N
    controlResourceSetToReleaseList     SEQUENCE(SIZE (1..3)) OF ControlResourceSetId         OPTIONAL,   -- Need N
    searchSpacesToAddModList            SEQUENCE(SIZE (1..10)) OF SearchSpace                 OPTIONAL,   -- Need N
    searchSpacesToReleaseList           SEQUENCE(SIZE (1..10)) OF SearchSpaceId               OPTIONAL,   -- Need N
    downlinkPreemption                  SetupRelease { DownlinkPreemption }                   OPTIONAL,   -- Need M
    tpc-PUSCH                           SetupRelease { PUSCH-TPC-CommandConfig }              OPTIONAL,   -- Need M
    tpc-PUCCH                           SetupRelease { PUCCH-TPC-CommandConfig }              OPTIONAL,   -- Need M
    tpc-SRS                             SetupRelease { SRS-TPC-CommandConfig}                 OPTIONAL,   -- Need M
    ...
}

-- TAG-PDCCH-CONFIG-STOP
-- ASN1STOP
```

***PDCCH-Config* field descriptions**
controlResourceSetToAddModList List of UE specifically configured Control Resource Sets (CORESETs) to be used by the UE. The network configures at most 3 CORESETs per BWP per cell (including UE-specific and common CORESETs). In case network reconfigures control resource set with the same *ControlResourceSetId* as used for *commonControlResourceSet* configured via *PDCCH-ConfigCommon*, the configuration from *PDCCH-Config* always takes precedence and should not be updated by the UE based on *servingCellConfigCommon*.
downlinkPreemption Configuration of downlink preemption indications to be monitored in this cell (see TS 38.213 [13], clause 11.2).
searchSpacesToAddModList List of UE specifically configured Search Spaces. The network configures at most 10 Search Spaces per BWP per cell (including UE-specific and common Search Spaces).
tpc-PUCCH Enable and configure reception of group TPC commands for PUCCH.
tpc-PUSCH Enable and configure reception of group TPC commands for PUSCH.
tpc-SRS Enable and configure reception of group TPC commands for SRS.

. . .

– *SearchSpace*

The IE *SearchSpace* defines how/where to search for PDCCH candidates. Each search space is associated with one *ControlResourceSet*. For a scheduled cell in the case of cross carrier scheduling, except for *nrofCandidates*, all the optional fields are absent (regardless of their presence conditions).

***SearchSpace* information element**

```
-- ASN1START
-- TAG-SEARCHSPACE-START

SearchSpace ::=                     SEQUENCE {
    searchSpaceId                       SearchSpaceId,
    controlResourceSetId                ControlResourceSetId                              OPTIONAL,   -- Cond SetupOnly
    monitoringSlotPeriodicityAndOffset  CHOICE {
        sl1                                 NULL,
        sl2                                 INTEGER (0..1),
        sl4                                 INTEGER (0..3),
        sl5                                 INTEGER (0..4),
        sl8                                 INTEGER (0..7),
        sl10                                INTEGER (0..9),
        sl16                                INTEGER (0..15),
        sl20                                INTEGER (0..19),
        sl40                                INTEGER (0..39),
        sl80                                INTEGER (0..79),
        sl160                               INTEGER (0..159),
        sl320                               INTEGER (0..319),
        sl640                               INTEGER (0..639),
        sl1280                              INTEGER (0..1279),
        sl2560                              INTEGER (0..2559)
    }                                                                                     OPTIONAL,   -- Cond Setup
    duration                            INTEGER (2..2559)                                 OPTIONAL,   -- Need R
    monitoringSymbolsWithinSlot         BIT STRING (SIZE (14))                            OPTIONAL,   -- Cond Setup
    nrofCandidates                      SEQUENCE {
        aggregationLevel1                   ENUMERATED {n0, n1, n2, n3, n4, n5, n6, n8},
        aggregationLevel2                   ENUMERATED {n0, n1, n2, n3, n4, n5, n6, n8},
        aggregationLevel4                   ENUMERATED {n0, n1, n2, n3, n4, n5, n6, n8},
        aggregationLevel8                   ENUMERATED {n0, n1, n2, n3, n4, n5, n6, n8},
        aggregationLevel16                  ENUMERATED {n0, n1, n2, n3, n4, n5, n6, n8}
    }                                                                                     OPTIONAL,   -- Cond Setup
    searchSpaceType                     CHOICE {
```

. . .

```
        ue-Specific                         SEQUENCE {
            dci-Formats                         ENUMERATED {formats0-0-And-1-0, formats0-1-And-1-1},
            ...
        }
    }                                                                                 OPTIONAL    -- Cond Setup
}

-- TAG-SEARCHSPACE-STOP
-- ASN1STOP
```

***SearchSpace* field descriptions**
common Configures this search space as common search space (CSS) and DCI formats to monitor.
controlResourceSetId The CORESET applicable for this SearchSpace. Value 0 identifies the common CORESET#0 configured in MIB and in *ServingCellConfigCommon*. Values 1..*maxNrofControlResourceSets-1* identify CORESETs configured in System Information or by dedicated signalling. The CORESETs with *non-zero controlResourceSetId* are configured in the same BWP as this *SearchSpace*.
dummy1, dummy2 This field is not used in the specification. If received it shall be ignored by the UE.
dci-Format0-0-AndFormat1-0 If configured, the UE monitors the DCI formats 0_0 and 1_0 according to TS 38.213 [13], clause 10.1.
dci-Format2-0 If configured, UE monitors the DCI format 2_0 according to TS 38.213 [13], clause 10.1, 11.1.1.
dci-Format2-1 If configured, UE monitors the DCI format 2_1 according to TS 38.213 [13], clause 10.1, 11.2.
dci-Format2-2 If configured, UE monitors the DCI format 2_2 according to TS 38.213 [13], clause 10.1, 11.3.
dci-Format2-3 If configured, UE monitors the DCI format 2_3 according to TS 38.213 [13], clause 10.1, 11.4
dci-Formats Indicates whether the UE monitors in this USS for DCI formats 0-0 and 1-0 or for formats 0-1 and 1-1.
duration Number of consecutive slots that a SearchSpace lasts in every occasion, i.e., upon every period as given in the *periodicityAndOffset*. If the field is absent, the UE applies the value 1 slot, except for DCI format 2_0. The UE ignores this field for DCI format 2_0. The maximum valid duration is periodicity-1 (periodicity as given in the *monitoringSlotPeriodicityAndOffset*).
monitoringSlotPeriodicityAndOffset Slots for PDCCH Monitoring configured as periodicity and offset. If the UE is configured to monitor DCI format 2_1, only the values 'sl1', 'sl2' or 'sl4' are applicable. If the UE is configured to monitor DCI format 2_0, only the values 'sl1', 'sl2', 'sl4', 'sl5', 'sl8', 'sl10', 'sl16', and 'sl20' are applicable (see TS 38.213 [13], clause 10).
monitoringSymbolsWithinSlot The first symbol(s) for PDCCH monitoring in the slots configured for PDCCH monitoring (see *monitoringSlotPeriodicityAndOffset* and *duration*). The most significant (left) bit represents the first OFDM in a slot, and the second most significant (left) bit represents the second OFDM symbol in a slot and so on. The bit(s) set to one identify the first OFDM symbol(s) of the control resource set within a slot. If the cyclic prefix of the BWP is set to extended CP, the last two bits within the bit string shall be ignored by the UE . For DCI format 2_0, the first one symbol applies if the *duration* of CORESET (in the IE *ControlResourceSet*) identified by *controlResourceSetId* indicates 3 symbols, the first two symbols apply if the *duration* of CORESET identified by *controlResourceSetId* indicates 2 symbols, and the first three symbols apply if the *duration* of CORESET identified by *controlResourceSetId* indicates 1 symbol. See TS 38.213 [13], clause 10.
nrofCandidates-SFI The number of PDCCH candidates specifically for format 2-0 for the configured aggregation level. If an aggregation level is absent, the UE does not search for any candidates with that aggregation level. The network configures only one aggregationLevel and the corresponding number of candidates (see TS 38.213 [13], clause 11.1.1).
nrofCandidates Number of PDCCH candidates per aggregation level. The number of candidates and aggregation levels configured here applies to all formats unless a particular value is specified or a format-specific value is provided (see inside *searchSpaceType*). If configured in the *SearchSpace* of a cross carrier scheduled cell, this field determines the number of candidates and aggregation levels to be used on the linked scheduling cell (see TS 38.213 [13], clause 10).

searchSpaceId Identity of the search space. SearchSpaceId = 0 identifies the *searchSpaceZero* configured via PBCH (MIB) or *ServingCellConfigCommon* and may hence not be used in the *SearchSpace* IE. The *searchSpaceId* is unique among the BWPs of a Serving Cell. In case of cross carrier scheduling, search spaces with the same *searchSpaceId* in scheduled cell and scheduling cell are linked to each other. The UE applies the search space for the scheduled cell only if the DL BWPs in which the linked search spaces are configured in scheduling cell and scheduled cell are both active.
searchSpaceType Indicates whether this is a common search space (present) or a UE specific search space as well as DCI formats to monitor for.
ue-Specific Configures this search space as UE specific search space (USS). The UE monitors the DCI format with CRC scrambled by C-RNTI, CS-RNTI (if configured), and SP-CSI-RNTI (if configured)

90. The Samsung 5G Accused Products further practice the step of not monitoring a common signal in the at least one first symbol. For example, this functionality is described in the 5G Standard, including but not limited to in 3GPP TS 38.213 section 10 and 3GPP TS 38.331 sections 5, 6, and 13.

3GPP TS 38.213

10.1 UE procedure for determining physical downlink control channel assignment

A set of PDCCH candidates for a UE to monitor is defined in terms of PDCCH search space sets. A search space set can be a CSS set or a USS set. A UE monitors PDCCH candidates in one or more of the following search spaces sets

- a Type0-PDCCH CSS set configured by *pdcch-ConfigSIB1* in *MIB* or by *searchSpaceSIB1* in *PDCCH-ConfigCommon* or by *searchSpaceZero* in *PDCCH-ConfigCommon* for a DCI format with CRC scrambled by a SI-RNTI on the primary cell of the MCG

- a Type0A-PDCCH CSS set configured by *searchSpaceOtherSystemInformation* in *PDCCH-ConfigCommon* for a DCI format with CRC scrambled by a SI-RNTI on the primary cell of the MCG

. . .

- a USS set configured by *SearchSpace* in *PDCCH-Config* with *searchSpaceType* = *ue-Specific* for DCI formats with CRC scrambled by C-RNTI, MCS-C-RNTI, SP-CSI-RNTI, or CS-RNTI(s).

3GPP TS 38.331

5.2.2.3.2 Acquisition of an SI message

For SI message acquisition PDCCH monitoring occasion(s) are determined according to *searchSpaceOtherSystemInformation*. If *searchSpaceOtherSystemInformation* is set to zero, PDCCH monitoring occasions for SI message reception in SI-window are same as PDCCH monitoring occasions for *SIB1* where the mapping between PDCCH monitoring occasions and SSBs is specified in TS 38.213[13]. If *searchSpaceOtherSystemInformation* is not set to zero, PDCCH monitoring occasions for SI message are determined based on search space indicated by *searchSpaceOtherSystemInformation*. PDCCH monitoring occasions for SI message which are not overlapping with UL symbols (determined according to *tdd-UL-DL-ConfigurationCommon*) are sequentially numbered from one in the SI window. The $[x \times N+K]^{th}$ PDCCH monitoring occasion (s) for SI message in SI-window corresponds to the K^{th} transmitted SSB, where x = 0, 1, ...X-1, K = 1, 2, …N, N is the number of actual transmitted SSBs determined according to *ssb-PositionsInBurst* in *SIB1* and X is equal to CEIL(number of PDCCH monitoring occasions in SI-window/N). The actual transmitted SSBs are sequentially numbered from one in ascending order of their SSB indexes. The UE assumes that, in the SI window, PDCCH for an SI message is transmitted in at least one PDCCH monitoring occasion corresponding to each transmitted SSB and thus the selection of SSB for the reception SI messages is up to UE implementation.

. . .

6.3.2 Radio resource control information elements

. . .

***PDCCH-ConfigCommon* information element**

```
-- ASN1START
-- TAG-PDCCH-CONFIGCOMMON-START

PDCCH-ConfigCommon ::=              SEQUENCE {
    controlResourceSetZero              ControlResourceSetZero                              OPTIONAL,    -- Cond InitialBWP-Only
    commonControlResourceSet            ControlResourceSet                                  OPTIONAL,    -- Need R
    searchSpaceZero                     SearchSpaceZero                                     OPTIONAL,    -- Cond InitialBWP-Only
    commonSearchSpaceList               SEQUENCE (SIZE(1..4)) OF SearchSpace                OPTIONAL,    -- Need R
    searchSpaceSIB1                     SearchSpaceId                                       OPTIONAL,    -- Need S
    searchSpaceOtherSystemInformation   SearchSpaceId                                       OPTIONAL,    -- Need S
    pagingSearchSpace                   SearchSpaceId                                       OPTIONAL,    -- Need S
    ra-SearchSpace                      SearchSpaceId                                       OPTIONAL,    -- Need S
    ...,
    [[
    firstPDCCH-MonitoringOccasionOfPO   CHOICE {
        sCS15KHZoneT                                                        SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..139),
        sCS30KHZoneT-SCS15KHZhalfT                                          SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..279),
        sCS60KHZoneT-SCS30KHZhalfT-SCS15KHZquarterT                         SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..559),
        sCS120KHZoneT-SCS60KHZhalfT-SCS30KHZquarterT-SCS15KHZoneEighthT     SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..1119),
        sCS120KHZhalfT-SCS60KHZquarterT-SCS30KHZoneEighthT-SCS15KHZoneSixteenthT SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..2239),
        sCS120KHZquarterT-SCS60KHZoneEighthT-SCS30KHZoneSixteenthT          SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..4479),
        sCS120KHZoneEighthT-SCS60KHZoneSixteenthT                           SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..8959),
        sCS120KHZoneSixteenthT                                              SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..17919)
    }                                                                                               OPTIONAL    -- Cond
OtherBWP
    ]]
}

-- TAG-PDCCH-CONFIGCOMMON-STOP
-- ASN1STOP
```

***PDCCH-ConfigCommon* field descriptions**
commonControlResourceSet An additional common control resource set which may be configured and used for any common or UE-specific search space. If the network configures this field, it uses a *ControlResourceSetId* other than 0 for this *ControlResourceSet*. The network configures the *commonControlResourceSet* in *SIB1* so that it is contained in the bandwidth of CORESET#0.
commonSearchSpaceList A list of additional common search spaces. If the network configures this field, it uses the *SearchSpaceIds* other than 0. If the field is included, it replaces any previous list, i.e. all the entries of the list are replaced and each of the *SearchSpace* entries is considered to be newly created and the conditions and Need codes for setup of the entry apply.
controlResourceSetZero Parameters of the common CORESET#0 which can be used in any common or UE-specific search spaces. The values are interpreted like the corresponding bits in *MIB pdcch-ConfigSIB1*. Even though this field is only configured in the initial BWP (BWP#0) *controlResourceSetZero* can be used in search spaces configured in other DL BWP(s) than the initial DL BWP if the conditions defined in TS 38.213 [13], clause 10 are satisfied.
firstPDCCH-MonitoringOccasionOfPO Indicates the first PDCCH monitoring occasion of each PO of the PF on this BWP, see TS 38.304 [20].
pagingSearchSpace ID of the Search space for paging (see TS 38.213 [13], clause 10.1). If the field is absent, the UE does not receive paging in this BWP (see TS 38.213 [13], clause 10).
ra-SearchSpace ID of the Search space for random access procedure (see TS 38.213 [13], clause 10.1). If the field is absent, the UE does not receive RAR in this BWP. This field is mandatory present in the DL BWP(s) if the conditions described in TS 38.321 [3], subclause 5.15 are met.
searchSpaceOtherSystemInformation ID of the Search space for other system information, i.e., *SIB2* and beyond (see TS 38.213 [13], clause 10.1) If the field is absent, the UE does not receive other system information in this BWP.
searchSpaceSIB1 ID of the search space for *SIB1* message. In the initial DL BWP of the UE's PCell, the network sets this field to 0. If the field is absent, the UE does not receive *SIB1* in this BWP. (see TS 38.213 [13], clause 10)
searchSpaceZero Parameters of the common SearchSpace#0. The values are interpreted like the corresponding bits in *MIB pdcch-ConfigSIB1*. Even though this field is only configured in the initial BWP (BWP#0), *searchSpaceZero* can be used in search spaces configured in other DL BWP(s) than the initial DL BWP if the conditions described in TS 38.213 [13], clause 10, are satisfied.

. . .

***PDCCH-ConfigSIB1* information element**

```
-- ASN1START
-- TAG-PDCCH-CONFIGSIB1-START

PDCCH-ConfigSIB1 ::=             SEQUENCE {
    controlResourceSetZero           ControlResourceSetZero,
    searchSpaceZero                  SearchSpaceZero
}

-- TAG-PDCCH-CONFIGSIB1-STOP
-- ASN1STOP
```

***PDCCH-ConfigSIB1* field descriptions**
controlResourceSetZero Determines a common ControlResourceSet (CORESET) with ID #0, see TS 38.213 [13], clause 13.
searchSpaceZero Determines a common search space with ID #0, see TS 38.213 [13], clause 13.

. . .

– *SearchSpace*

The IE *SearchSpace* defines how/where to search for PDCCH candidates. Each search space is associated with one *ControlResourceSet*. For a scheduled cell in the case of cross carrier scheduling, except for *nrofCandidates*, all the optional fields are absent (regardless of their presence conditions).

***SearchSpace* information element**

```
-- ASN1START
-- TAG-SEARCHSPACE-START

SearchSpace ::=                     SEQUENCE {
    searchSpaceId                       SearchSpaceId,
    controlResourceSetId                ControlResourceSetId                    OPTIONAL,    -- Cond SetupOnly
    monitoringSlotPeriodicityAndOffset  CHOICE {
        sl1                                 NULL,
        sl2                                 INTEGER (0..1),
        sl4                                 INTEGER (0..3),
        sl5                                 INTEGER (0..4),
        sl8                                 INTEGER (0..7),
        sl10                                INTEGER (0..9),
        sl16                                INTEGER (0..15),
        sl20                                INTEGER (0..19),
        sl40                                INTEGER (0..39),
        sl80                                INTEGER (0..79),
        sl160                               INTEGER (0..159),
        sl320                               INTEGER (0..319),
        sl640                               INTEGER (0..639),
        sl1280                              INTEGER (0..1279),
        sl2560                              INTEGER (0..2559)
    }                                                                           OPTIONAL,    -- Cond Setup
    duration                            INTEGER (2..2559)                       OPTIONAL,    -- Need R
    monitoringSymbolsWithinSlot         BIT STRING (SIZE (14))                  OPTIONAL,    -- Cond Setup
    nrofCandidates                      SEQUENCE {
        aggregationLevel1                   ENUMERATED {n0, n1, n2, n3, n4, n5, n6, n8},
        aggregationLevel2                   ENUMERATED {n0, n1, n2, n3, n4, n5, n6, n8},
        aggregationLevel4                   ENUMERATED {n0, n1, n2, n3, n4, n5, n6, n8},
        aggregationLevel8                   ENUMERATED {n0, n1, n2, n3, n4, n5, n6, n8},
        aggregationLevel16                  ENUMERATED {n0, n1, n2, n3, n4, n5, n6, n8}
    }                                                                           OPTIONAL,    -- Cond Setup
    searchSpaceType                     CHOICE {
        common                              SEQUENCE {
            dci-Format0-0-AndFormat1-0          SEQUENCE {
                ...
            }                                                                   OPTIONAL,    -- Need R
            dci-Format2-0                       SEQUENCE {
                nrofCandidates-SFI                  SEQUENCE {
                    aggregationLevel1                   ENUMERATED {n1, n2}     OPTIONAL,    -- Need R
                    aggregationLevel2                   ENUMERATED {n1, n2}     OPTIONAL,    -- Need R
                    aggregationLevel4                   ENUMERATED {n1, n2}     OPTIONAL,    -- Need R
                    aggregationLevel8                   ENUMERATED {n1, n2}     OPTIONAL,    -- Need R
                    aggregationLevel16                  ENUMERATED {n1, n2}     OPTIONAL     -- Need R
                },
                ...
            }                                                                   OPTIONAL,    -- Need R
            dci-Format2-1                       SEQUENCE {
                ...
            }                                                                   OPTIONAL,    -- Need R
            dci-Format2-2                       SEQUENCE {
                ...
            }                                                                   OPTIONAL,    -- Need R
            dci-Format2-3                       SEQUENCE {
                dummy1                              ENUMERATED {sl1, sl2, sl4, sl5, sl8, sl10, sl16, sl20}  OPTIONAL,    -- Cond Setup
                dummy2                              ENUMERATED {n1, n2},
                ...
            }                                                                   OPTIONAL     -- Need R
        },
        ue-Specific                         SEQUENCE {
            dci-Formats                         ENUMERATED {formats0-0-And-1-0, formats0-1-And-1-1},
            ...
        }
    }                                                                           OPTIONAL     -- Cond Setup
}

-- TAG-SEARCHSPACE-STOP
-- ASN1STOP
```

***SearchSpace* field descriptions**
common Configures this search space as common search space (CSS) and DCI formats to monitor.

. . .

monitoringSymbolsWithinSlot The first symbol(s) for PDCCH monitoring in the slots configured for PDCCH monitoring (see *monitoringSlotPeriodicityAndOffset* and *duration*). The most significant (left) bit represents the first OFDM in a slot, and the second most significant (left) bit represents the second OFDM symbol in a slot and so on. The bit(s) set to one identify the first OFDM symbol(s) of the control resource set within a slot. If the cyclic prefix of the BWP is set to extended CP, the last two bits within the bit string shall be ignored by the UE . For DCI format 2_0, the first one symbol applies if the *duration* of CORESET (in the IE *ControlResourceSet*) identified by *controlResourceSetId* indicates 3 symbols, the first two symbols apply if the *duration* of CORESET identified by *controlResourceSetId* indicates 2 symbols, and the first three symbols apply if the *duration* of CORESET identified by *controlResourceSetId* indicates 1 symbol. See TS 38.213 [13], clause 10.

. . .

ue-Specific Configures this search space as UE specific search space (USS). The UE monitors the DCI format with CRC scrambled by C-RNTI, CS-RNTI (if configured), and SP-CSI-RNTI (if configured)

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13 UE procedure for monitoring Type0-PDCCH CSS sets

If during cell search a UE determines from *MIB* that a CORESET for Type0-PDCCH CSS set is present, as described in Clause 4.1, the UE determines a number of consecutive resource blocks and a number of consecutive symbols for the CORESET of the Type0-PDCCH CSS set from *controlResourceSetZero* in *pdcch-ConfigSIB1*, as described in Tables 13-1 through 13-10, and determines PDCCH monitoring occasions from *searchSpaceZero* in *pdcch-ConfigSIB1*, included in *MIB*, as described in Tables 13-11 through 13-15. SFN_C and n_C are the SFN and slot index within a frame of the CORESET based on SCS of the CORESET and $SFN_{SSB,i}$ and $n_{SSB,i}$ are the SFN and slot index based on SCS of the CORESET, respectively, where the SS/PBCH block with index i overlaps in time with system frame $SFN_{SSB,i}$ and slot $n_{SSB,i}$. The symbols of the CORESET associated with *pdcch-ConfigSIB1* in *MIB* or with *searchSpaceSIB1* in *PDCCH-ConfigCommon* have normal cyclic prefix.

91. The Samsung 5G Accused Products further practice the step of monitoring, in the cell, the common signal in at least one second symbol of the downlink control region. For example, this functionality is described in the 5G Standard, including but not limited to in 3GPP TS 38.213 section 10 and 3GPP TS 38.331 sections 5, 6, and 13.

<u>3GPP TS 38.213</u>

10.1 UE procedure for determining physical downlink control channel assignment

A set of PDCCH candidates for a UE to monitor is defined in terms of PDCCH search space sets. A search space set can be a CSS set or a USS set. A UE monitors PDCCH candidates in one or more of the following search spaces sets

- a Type0-PDCCH CSS set configured by *pdcch-ConfigSIB1* in *MIB* or by *searchSpaceSIB1* in *PDCCH-ConfigCommon* or by *searchSpaceZero* in *PDCCH-ConfigCommon* for a DCI format with CRC scrambled by a SI-RNTI on the primary cell of the MCG
- a Type0A-PDCCH CSS set configured by *searchSpaceOtherSystemInformation* in *PDCCH-ConfigCommon* for a DCI format with CRC scrambled by a SI-RNTI on the primary cell of the MCG

. . .

For each DL BWP configured to a UE in a serving cell, a UE can be provided by higher layer signalling with $P \leq 3$ CORESETs. For each CORESET, the UE is provided the following by *ControlResourceSet*:

- a CORESET index p, $0 < p < 12$, by *controlResourceSetId*;
- a DM-RS scrambling sequence initialization value by *pdcch-DMRS-ScramblingID*;
- a precoder granularity for a number of REGs in the frequency domain where the UE can assume use of a same DM-RS precoder by *precoderGranularity*;
- a number of consecutive symbols provided by *duration*;

3GPP TS 38.331

5.2.2.3.2 Acquisition of an SI message

For SI message acquisition PDCCH monitoring occasion(s) are determined according to *searchSpaceOtherSystemInformation*. If *searchSpaceOtherSystemInformation* is set to zero, PDCCH monitoring occasions for SI message reception in SI-window are same as PDCCH monitoring occasions for *SIB1* where the mapping between PDCCH monitoring occasions and SSBs is specified in TS 38.213[13]. If *searchSpaceOtherSystemInformation* is not set to zero, PDCCH monitoring occasions for SI message are determined based on search space indicated by *searchSpaceOtherSystemInformation*. PDCCH monitoring occasions for SI message which are not overlapping with UL symbols (determined according to *tdd-UL-DL-ConfigurationCommon*) are sequentially numbered from one in the SI window. The $[x \times N+K]^{th}$ PDCCH monitoring occasion (s) for SI message in SI-window corresponds to the K^{th} transmitted SSB, where x = 0, 1, ...X-1, K = 1, 2, …N, N is the number of actual transmitted SSBs determined according to *ssb-PositionsInBurst* in *SIB1* and X is equal to CEIL(number of PDCCH monitoring occasions in SI-window/N). The actual transmitted SSBs are sequentially numbered from one in ascending order of their SSB indexes. The UE assumes that, in the SI window, PDCCH for an SI message is transmitted in at least one PDCCH monitoring occasion corresponding to each transmitted SSB and thus the selection of SSB for the reception SI messages is up to UE implementation.

. . .

6.3.2 Radio resource control information elements

. . .

***ControlResourceSet* information element**

```
-- ASN1START
-- TAG-CONTROLRESOURCESET-START

ControlResourceSet ::=              SEQUENCE {
    controlResourceSetId                ControlResourceSetId,

    frequencyDomainResources            BIT STRING (SIZE (45)),
    duration                            INTEGER (1..maxCoReSetDuration),
    cce-REG-MappingType                 CHOICE {
        interleaved                         SEQUENCE {
            reg-BundleSize                      ENUMERATED {n2, n3, n6},
            interleaverSize                     ENUMERATED {n2, n3, n6},
            shiftIndex                          INTEGER(0..maxNrofPhysicalResourceBlocks-1)       OPTIONAL -- Need S
        },
        nonInterleaved                      NULL
    },
    precoderGranularity                 ENUMERATED {sameAsREG-bundle, allContiguousRBs},
    tci-StatesPDCCH-ToAddList           SEQUENCE(SIZE (1..maxNrofTCI-StatesPDCCH)) OF TCI-StateId OPTIONAL, -- Cond NotSIB1-initialBWP
    tci-StatesPDCCH-ToReleaseList       SEQUENCE(SIZE (1..maxNrofTCI-StatesPDCCH)) OF TCI-StateId OPTIONAL, -- Cond NotSIB1-initialBWP
    tci-PresentInDCI                        ENUMERATED {enabled}                              OPTIONAL, -- Need S
    pdcch-DMRS-ScramblingID                 INTEGER (0..65535)                                OPTIONAL, -- Need S
    ...
}

-- TAG-CONTROLRESOURCESET-STOP
-- ASN1STOP
```

***ControlResourceSet* field descriptions**
cce-REG-MappingType Mapping of Control Channel Elements (CCE) to Resource Element Groups (REG) (see TS 38.211 [16], clauses 7.3.2.2 and 7.4.1.3.2).
controlResourceSetId Value 0 identifies the common CORESET configured in *MIB* and in *ServingCellConfigCommon* (*controlResourceSetZero*) and is hence not used here in the *ControlResourceSet* IE. Values 1..*maxNrofControlResourceSets-1* identify CORESETs configured by dedicated signalling or in *SIB1*. The *controlResourceSetId* is unique among the BWPs of a serving cell.
duration Contiguous time duration of the CORESET in number of symbols (see TS 38.211 [16], clause 7.3.2.2).
frequencyDomainResources Frequency domain resources for the CORESET. Each bit corresponds a group of 6 RBs, with grouping starting from the first RB group (see TS 38.213 [13], clause 10.1) in the BWP. The first (left-most / most significant) bit corresponds to the first RB group in the BWP, and so on. A bit that is set to 1 indicates that this RB group belongs to the frequency domain resource of this CORESET. Bits corresponding to a group of RBs not fully contained in the bandwidth part within which the CORESET is configured are set to zero (see TS 38.211 [16], clause 7.3.2.2).
interleaverSize Interleaver-size (see TS 38.211 [16], clause 7.3.2.2).
pdcch-DMRS-ScramblingID PDCCH DMRS scrambling initialization (see TS 38.211 [16], clause 7.4.1.3.1). When the field is absent the UE applies the value of the *physCellId* configured for this serving cell.
precoderGranularity Precoder granularity in frequency domain (see TS 38.211 [16], clauses 7.3.2.2 and 7.4.1.3.2).
reg-BundleSize Resource Element Groups (REGs) can be bundled to create REG bundles. This parameter defines the size of such bundles (see TS 38.211 [16], clause 7.3.2.2).
shiftIndex When the field is absent the UE applies the value of the *physCellId*configured for this serving cell (see TS 38.211 [16], clause 7.3.2.2).
tci-PresentInDCI This field indicates if TCI field is present or absent in DL-related DCI. When the field is absent the UE considers the TCI to be absent/disabled. In case of cross carrier scheduling, the network sets this field to enabled for the *ControlResourceSet* used for cross carrier scheduling in the scheduling cell (see TS 38.214 [19], clause 5.1.5).
tci-StatesPDCCH-ToAddList A subset of the TCI states defined in pdsch-Config included in the *BWP-DownlinkDedicated* corresponding to the serving cell and to the DL BWP to which the *ControlResourceSet* belong to. They are used for providing QCL relationships between the DL RS(s) in one RS Set (TCI-State) and the PDCCH DMRS ports (see TS 38.213 [13], clause 6.). The network configures at most *maxNrofTCI-StatesPDCCH* entries.

. . .

PDCCH-ConfigCommon information element

```
-- ASN1START
-- TAG-PDCCH-CONFIGCOMMON-START

PDCCH-ConfigCommon ::=              SEQUENCE {
    controlResourceSetZero              ControlResourceSetZero                                      OPTIONAL,   -- Cond InitialBWP-Only
    commonControlResourceSet            ControlResourceSet                                          OPTIONAL,   -- Need R
    searchSpaceZero                     SearchSpaceZero                                             OPTIONAL,   -- Cond InitialBWP-Only
    commonSearchSpaceList               SEQUENCE (SIZE(1..4)) OF SearchSpace                        OPTIONAL,   -- Need R
    searchSpaceSIB1                     SearchSpaceId                                               OPTIONAL,   -- Need S
    searchSpaceOtherSystemInformation   SearchSpaceId                                               OPTIONAL,   -- Need S
    pagingSearchSpace                   SearchSpaceId                                               OPTIONAL,   -- Need S
    ra-SearchSpace                      SearchSpaceId                                               OPTIONAL,   -- Need S
    ...,
    [[
    firstPDCCH-MonitoringOccasionOfPO   CHOICE {
        sCS15KHZoneT                                                        SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..139),
        sCS30KHZoneT-SCS15KHZhalfT                                          SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..279),
        sCS60KHZoneT-SCS30KHZhalfT-SCS15KHZquarterT                         SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..559),
        sCS120KHZoneT-SCS60KHZhalfT-SCS30KHZquarterT-SCS15KHZoneEighthT     SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..1119),
        sCS120KHZhalfT-SCS60KHZquarterT-SCS30KHZoneEighthT-SCS15KHZoneSixteenthT SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..2239),
        sCS120KHZquarterT-SCS60KHZoneEighthT-SCS30KHZoneSixteenthT          SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..4479),
        sCS120KHZoneEighthT-SCS60KHZoneSixteenthT                           SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..8959),
        sCS120KHZoneSixteenthT                                              SEQUENCE (SIZE (1..maxPO-perPF)) OF INTEGER (0..17919)
    }                                                                                                       OPTIONAL      -- Cond
OtherBWP
    ]]
}

-- TAG-PDCCH-CONFIGCOMMON-STOP
-- ASN1STOP
```

PDCCH-ConfigCommon field descriptions
commonControlResourceSet An additional common control resource set which may be configured and used for any common or UE-specific search space. If the network configures this field, it uses a *ControlResourceSetId* other than 0 for this *ControlResourceSet*. The network configures the *commonControlResourceSet* in *SIB1* so that it is contained in the bandwidth of CORESET#0.
commonSearchSpaceList A list of additional common search spaces. If the network configures this field, it uses the *SearchSpaceIds* other than 0. If the field is included, it replaces any previous list, i.e. all the entries of the list are replaced and each of the *SearchSpace* entries is considered to be newly created and the conditions and Need codes for setup of the entry apply.
controlResourceSetZero Parameters of the common CORESET#0 which can be used in any common or UE-specific search spaces. The values are interpreted like the corresponding bits in *MIB pdcch-ConfigSIB1*. Even though this field is only configured in the initial BWP (BWP#0) *controlResourceSetZero* can be used in search spaces configured in other DL BWP(s) than the initial DL BWP if the conditions defined in TS 38.213 [13], clause 10 are satisfied.
firstPDCCH-MonitoringOccasionOfPO Indicates the first PDCCH monitoring occasion of each PO of the PF on this BWP, see TS 38.304 [20].
pagingSearchSpace ID of the Search space for paging (see TS 38.213 [13], clause 10.1). If the field is absent, the UE does not receive paging in this BWP (see TS 38.213 [13], clause 10).
ra-SearchSpace ID of the Search space for random access procedure (see TS 38.213 [13], clause 10.1). If the field is absent, the UE does not receive RAR in this BWP. This field is mandatory present in the DL BWP(s) if the conditions described in TS 38.321 [3], subclause 5.15 are met.
searchSpaceOtherSystemInformation ID of the Search space for other system information, i.e., *SIB2* and beyond (see TS 38.213 [13], clause 10.1) If the field is absent, the UE does not receive other system information in this BWP.
searchSpaceSIB1 ID of the search space for *SIB1* message. In the initial DL BWP of the UE's PCell, the network sets this field to 0. If the field is absent, the UE does not receive *SIB1* in this BWP. (see TS 38.213 [13], clause 10)
searchSpaceZero Parameters of the common SearchSpace#0. The values are interpreted like the corresponding bits in *MIB pdcch-ConfigSIB1*. Even though this field is only configured in the initial BWP (BWP#0), *searchSpaceZero* can be used in search spaces configured in other DL BWP(s) than the initial DL BWP if the conditions described in TS 38.213 [13], clause 10, are satisfied.

. . .

PDCCH-ConfigSIB1 information element

```
-- ASN1START
-- TAG-PDCCH-CONFIGSIB1-START

PDCCH-ConfigSIB1 ::=            SEQUENCE {
    controlResourceSetZero          ControlResourceSetZero,
    searchSpaceZero                 SearchSpaceZero
}

-- TAG-PDCCH-CONFIGSIB1-STOP
-- ASN1STOP
```

PDCCH-ConfigSIB1 field descriptions
controlResourceSetZero Determines a common ControlResourceSet (CORESET) with ID #0, see TS 38.213 [13], clause 13.
searchSpaceZero Determines a common search space with ID #0, see TS 38.213 [13], clause 13.

. . .

– *SearchSpace*

The IE *SearchSpace* defines how/where to search for PDCCH candidates. Each search space is associated with one *ControlResourceSet*. For a scheduled cell in the case of cross carrier scheduling, except for *nrofCandidates*, all the optional fields are absent (regardless of their presence conditions).

***SearchSpace* information element**

```
-- ASN1START
-- TAG-SEARCHSPACE-START

SearchSpace ::=                     SEQUENCE {
    searchSpaceId                       SearchSpaceId,
    controlResourceSetId                ControlResourceSetId                                OPTIONAL,   -- Cond SetupOnly
    monitoringSlotPeriodicityAndOffset  CHOICE {
        sl1                                 NULL,
        sl2                                 INTEGER (0..1),
        sl4                                 INTEGER (0..3),
        sl5                                 INTEGER (0..4),
        sl8                                 INTEGER (0..7),
        sl10                                INTEGER (0..9),
        sl16                                INTEGER (0..15),
        sl20                                INTEGER (0..19),
        sl40                                INTEGER (0..39),
        sl80                                INTEGER (0..79),
        sl160                               INTEGER (0..159),
        sl320                               INTEGER (0..319),
        sl640                               INTEGER (0..639),
        sl1280                              INTEGER (0..1279),
        sl2560                              INTEGER (0..2559)
    }                                                                                       OPTIONAL,   -- Cond Setup
    duration                            INTEGER (2..2559)                                   OPTIONAL,   -- Need R
    monitoringSymbolsWithinSlot         BIT STRING (SIZE (14))                              OPTIONAL,   -- Cond Setup
    nrofCandidates                      SEQUENCE {
        aggregationLevel1                   ENUMERATED {n0, n1, n2, n3, n4, n5, n6, n8},
        aggregationLevel2                   ENUMERATED {n0, n1, n2, n3, n4, n5, n6, n8},
        aggregationLevel4                   ENUMERATED {n0, n1, n2, n3, n4, n5, n6, n8},
        aggregationLevel8                   ENUMERATED {n0, n1, n2, n3, n4, n5, n6, n8},
        aggregationLevel16                  ENUMERATED {n0, n1, n2, n3, n4, n5, n6, n8}
    }                                                                                       OPTIONAL,   -- Cond Setup
    searchSpaceType                     CHOICE {
        common                              SEQUENCE {
            dci-Format0-0-AndFormat1-0          SEQUENCE {
                ...
            }                                                                               OPTIONAL,   -- Need R
            dci-Format2-0                       SEQUENCE {
                nrofCandidates-SFI                  SEQUENCE {
                    aggregationLevel1                   ENUMERATED {n1, n2}                 OPTIONAL,   -- Need R
                    aggregationLevel2                   ENUMERATED {n1, n2}                 OPTIONAL,   -- Need R
                    aggregationLevel4                   ENUMERATED {n1, n2}                 OPTIONAL,   -- Need R
                    aggregationLevel8                   ENUMERATED {n1, n2}                 OPTIONAL,   -- Need R
                    aggregationLevel16                  ENUMERATED {n1, n2}                 OPTIONAL    -- Need R
                },
                ...
            }                                                                               OPTIONAL,   -- Need R
            dci-Format2-1                       SEQUENCE {
                ...
            }                                                                               OPTIONAL,   -- Need R
            dci-Format2-2                       SEQUENCE {
                ...
```

```
            }                                                                               OPTIONAL,   -- Need R
            dci-Format2-3                       SEQUENCE {
                dummy1                              ENUMERATED {sl1, sl2, sl4, sl5, sl8, sl10, sl16, sl20}  OPTIONAL,   -- Cond Setup
                dummy2                              ENUMERATED {n1, n2},
                ...
            }                                                                               OPTIONAL    -- Need R
        },
```

. . .

SearchSpace field descriptions
common Configures this search space as common search space (CSS) and DCI formats to monitor.
controlResourceSetId The CORESET applicable for this SearchSpace. Value 0 identifies the common CORESET#0 configured in MIB and in *ServingCellConfigCommon*. Values 1..*maxNrofControlResourceSets-1* identify CORESETs configured in System Information or by dedicated signalling. The CORESETs with *non-zero controlResourceSetId* are configured in the same BWP as this *SearchSpace*.
dummy1, dummy2 This field is not used in the specification. If received it shall be ignored by the UE.
dci-Format0-0-AndFormat1-0 If configured, the UE monitors the DCI formats 0_0 and 1_0 according to TS 38.213 [13], clause 10.1.
dci-Format2-0 If configured, UE monitors the DCI format 2_0 according to TS 38.213 [13], clause 10.1, 11.1.1.
dci-Format2-1 If configured, UE monitors the DCI format 2_1 according to TS 38.213 [13], clause 10.1, 11.2.
dci-Format2-2 If configured, UE monitors the DCI format 2_2 according to TS 38.213 [13], clause 10.1, 11.3.
dci-Format2-3 If configured, UE monitors the DCI format 2_3 according to TS 38.213 [13], clause 10.1, 11.4
dci-Formats Indicates whether the UE monitors in this USS for DCI formats 0-0 and 1-0 or for formats 0-1 and 1-1.
duration Number of consecutive slots that a SearchSpace lasts in every occasion, i.e., upon every period as given in the *periodicityAndOffset*. If the field is absent, the UE applies the value 1 slot, except for DCI format 2_0. The UE ignores this field for DCI format 2_0. The maximum valid duration is periodicity-1 (periodicity as given in the *monitoringSlotPeriodicityAndOffset*).
monitoringSlotPeriodicityAndOffset Slots for PDCCH Monitoring configured as periodicity and offset. If the UE is configured to monitor DCI format 2_1, only the values 'sl1', 'sl2' or 'sl4' are applicable. If the UE is configured to monitor DCI format 2_0, only the values 'sl1', 'sl2', 'sl4', 'sl5', 'sl8', 'sl10', 'sl16', and 'sl20' are applicable (see TS 38.213 [13], clause 10).
monitoringSymbolsWithinSlot The first symbol(s) for PDCCH monitoring in the slots configured for PDCCH monitoring (see *monitoringSlotPeriodicityAndOffset* and *duration*). The most significant (left) bit represents the first OFDM in a slot, and the second most significant (left) bit represents the second OFDM symbol in a slot and so on. The bit(s) set to one identify the first OFDM symbol(s) of the control resource set within a slot. If the cyclic prefix of the BWP is set to extended CP, the last two bits within the bit string shall be ignored by the UE . For DCI format 2_0, the first one symbol applies if the *duration* of CORESET (in the IE *ControlResourceSet*) identified by *controlResourceSetId* indicates 3 symbols, the first two symbols apply if the *duration* of CORESET identified by *controlResourceSetId* indicates 2 symbols, and the first three symbols apply if the *duration* of CORESET identified by *controlResourceSetId* indicates 1 symbol. See TS 38.213 [13], clause 10.
nrofCandidates-SFI The number of PDCCH candidates specifically for format 2-0 for the configured aggregation level. If an aggregation level is absent, the UE does not search for any candidates with that aggregation level. The network configures only one aggregationLevel and the corresponding number of candidates (see TS 38.213 [13], clause 11.1.1).
nrofCandidates Number of PDCCH candidates per aggregation level. The number of candidates and aggregation levels configured here applies to all formats unless a particular value is specified or a format-specific value is provided (see inside *searchSpaceType*). If configured in the *SearchSpace* of a cross carrier scheduled cell, this field determines the number of candidates and aggregation levels to be used on the linked scheduling cell (see TS 38.213 [13], clause 10).
searchSpaceId Identity of the search space. SearchSpaceId = 0 identifies the *searchSpaceZero* configured via PBCH (MIB) or *ServingCellConfigCommon* and may hence not be used in the *SearchSpace* IE. The *searchSpaceId* is unique among the BWPs of a Serving Cell. In case of cross carrier scheduling, search spaces with the same *searchSpaceId* in scheduled cell and scheduling cell are linked to each other. The UE applies the search space for the scheduled cell only if the DL BWPs in which the linked search spaces are configured in scheduling cell and scheduled cell are both active.
searchSpaceType Indicates whether this is a common search space (present) or a UE specific search space as well as DCI formats to monitor for.
ue-Specific Configures this search space as UE specific search space (USS). The UE monitors the DCI format with CRC scrambled by C-RNTI, CS-RNTI (if configured), and SP-CSI-RNTI (if configured)

. . .

13 UE procedure for monitoring Type0-PDCCH CSS sets

If during cell search a UE determines from *MIB* that a CORESET for Type0-PDCCH CSS set is present, as described in Clause 4.1, the UE determines a number of consecutive resource blocks and a number of consecutive symbols for the CORESET of the Type0-PDCCH CSS set from *controlResourceSetZero* in *pdcch-ConfigSIB1*, as described in Tables 13-1 through 13-10, and determines PDCCH monitoring occasions from *searchSpaceZero* in *pdcch-ConfigSIB1*, included in *MIB*, as described in Tables 13-11 through 13-15. SFN_C and n_C are the SFN and slot index within a frame of the CORESET based on SCS of the CORESET and $\mathrm{SFN}_{\mathrm{SSB},i}$ and $n_{\mathrm{SSB}i}$ are the SFN and slot index based on SCS of the CORESET, respectively, where the SS/PBCH block with index i overlaps in time with system frame $\mathrm{SFN}_{\mathrm{SSB},i}$ and slot $n_{\mathrm{SSB}i}$. The symbols of the CORESET associated with *pdcch-ConfigSIB1* in *MIB* or with *searchSpaceSIB1* in *PDCCH-ConfigCommon* have normal cyclic prefix.

92. The Samsung 5G Accused Products further practice the foregoing step wherein the common signal and the UE specific signal indicate resources in different symbols of a data region of the subframe. For example, this functionality is described in the 5G Standard, including but not limited to in 3GPP TS 38.214 section 5, 3GPP TS 38.300 section 5, and 3GPP TS 38.331 section 6.

3GPP TS 38.214

5.1.2 Resource allocation

5.1.2.1 Resource allocation in time domain

When the UE is scheduled to receive PDSCH by a DCI, the *Time domain resource assignment* field value m of the DCI provides a row index $m + 1$ to an allocation table. The determination of the used resource allocation table is defined in clause 5.1.2.1.1. The indexed row defines the slot offset K_0, the start and length indicator $SLIV$, or directly the start symbol S and the allocation length L, and the PDSCH mapping type to be assumed in the PDSCH reception.

. . .

5.1.2.1.1 Determination of the resource allocation table to be used for PDSCH

Table 5.1.2.1.1-1 defines which PDSCH time domain resource allocation configuration to apply. Either a default PDSCH time domain allocation A, B or C according to tables 5.1.2.1.1-2, 5.1.2.1.1-3, 5.1.2.1.1-4 and 5.1.2.1.1-5 is applied, or the higher layer configured *pdsch-TimeDomainAllocationList* in either *pdsch-ConfigCommon* or *pdsch-Config* is applied.

Table 5.1.2.1.1-1: Applicable PDSCH time domain resource allocation

RNTI	PDCCH search space	SS/PBCH block and CORESET multiplexing pattern	*pdsch-ConfigCommon* includes *pdsch-TimeDomainAllocationList*	*pdsch-Config* includes *pdsch-TimeDomainAllocationList*	PDSCH time domain resource allocation to apply
SI-RNTI	Type0 common	1	-	-	Default A for normal CP
		2	-	-	Default B
		3	-	-	Default C
SI-RNTI	Type0A common	1	No	-	Default A
		2	No	-	Default B
		3	No	-	Default C
		1,2,3	Yes	-	*pdsch-TimeDomainAllocationList provided in pdsch-ConfigCommon*
. . .					
C-RNTI, MCS-C-RNTI, CS-RNTI	Any common search space not associated with CORESET 0	1,2,3	No	No	Default A
		1,2,3	Yes	No	*pdsch-TimeDomainAllocationList* provided in *pdsch-ConfigCommon*
	UE specific search space	1,2,3	No/Yes	Yes	*pdsch-TimeDomainAllocationList* provided in *pdsch-Config*

3GPP TS 38.300

5.2 Downlink

5.2.1 Downlink transmission scheme

A closed loop Demodulation Reference Signal (DMRS) based spatial multiplexing is supported for Physical Downlink Shared Channel (PDSCH). Up to 8 and 12 orthogonal DL DMRS ports are supported for type 1 and type 2 DMRS respectively. Up to 8 orthogonal DL DMRS ports per UE are supported for SU-MIMO and up to 4 orthogonal DL DMRS ports per UE are supported for MU-MIMO. The number of SU-MIMO code words is one for 1-4 layer transmissions and two for 5-8 layer transmissions.

The DMRS and corresponding PDSCH are transmitted using the same precoding matrix and the UE does not need to know the precoding matrix to demodulate the transmission. The transmitter may use different precoder matrix for different parts of the transmission bandwidth, resulting in frequency selective precoding. The UE may also assume that the same precoding matrix is used across a set of Physical Resource Blocks (PRBs) denoted Precoding Resource Block Group (PRG).

Transmission durations from 2 to 14 symbols in a slot is supported.

Aggregation of multiple slots with Transport Block (TB) repetition is supported.

3GPP TS 38.331

6.3.2 Radio resource control information elements

. . .

***ControlResourceSet* information element**

```
-- ASN1START
-- TAG-CONTROLRESOURCESET-START

ControlResourceSet ::=              SEQUENCE {
    controlResourceSetId                ControlResourceSetId,

    frequencyDomainResources            BIT STRING (SIZE (45)),
    duration                            INTEGER (1..maxCoReSetDuration),
    cce-REG-MappingType                 CHOICE {
        interleaved                         SEQUENCE {
            reg-BundleSize                      ENUMERATED {n2, n3, n6},
            interleaverSize                     ENUMERATED {n2, n3, n6},
            shiftIndex                          INTEGER(0..maxNrofPhysicalResourceBlocks-1)       OPTIONAL -- Need S
        },
        nonInterleaved                      NULL
    },
    precoderGranularity                 ENUMERATED {sameAsREG-bundle, allContiguousRBs},
    tci-StatesPDCCH-ToAddList           SEQUENCE(SIZE (1..maxNrofTCI-StatesPDCCH)) OF TCI-StateId OPTIONAL, -- Cond NotSIB1-initialBWP
    tci-StatesPDCCH-ToReleaseList       SEQUENCE(SIZE (1..maxNrofTCI-StatesPDCCH)) OF TCI-StateId OPTIONAL, -- Cond NotSIB1-initialBWP
    tci-PresentInDCI                        ENUMERATED {enabled}                                  OPTIONAL, -- Need S
    pdcch-DMRS-ScramblingID                 INTEGER (0..65535)                                    OPTIONAL, -- Need S
    ...
}

-- TAG-CONTROLRESOURCESET-STOP
-- ASN1STOP
```

ControlResourceSet field descriptions
cce-REG-MappingType Mapping of Control Channel Elements (CCE) to Resource Element Groups (REG) (see TS 38.211 [16], clauses 7.3.2.2 and 7.4.1.3.2).
controlResourceSetId Value 0 identifies the common CORESET configured in *MIB* and in *ServingCellConfigCommon* (*controlResourceSetZero*) and is hence not used here in the *ControlResourceSet* IE. Values 1..*maxNrofControlResourceSets-1* identify CORESETs configured by dedicated signalling or in *SIB1*. The *controlResourceSetId* is unique among the BWPs of a serving cell.
duration Contiguous time duration of the CORESET in number of symbols (see TS 38.211 [16], clause 7.3.2.2).
frequencyDomainResources Frequency domain resources for the CORESET. Each bit corresponds a group of 6 RBs, with grouping starting from the first RB group (see TS 38.213 [13], clause 10.1) in the BWP. The first (left-most / most significant) bit corresponds to the first RB group in the BWP, and so on. A bit that is set to 1 indicates that this RB group belongs to the frequency domain resource of this CORESET. Bits corresponding to a group of RBs not fully contained in the bandwidth part within which the CORESET is configured are set to zero (see TS 38.211 [16], clause 7.3.2.2).
interleaverSize Interleaver-size (see TS 38.211 [16], clause 7.3.2.2).
pdcch-DMRS-ScramblingID PDCCH DMRS scrambling initialization (see TS 38.211 [16], clause 7.4.1.3.1). When the field is absent the UE applies the value of the *physCellId* configured for this serving cell.
precoderGranularity Precoder granularity in frequency domain (see TS 38.211 [16], clauses 7.3.2.2 and 7.4.1.3.2).
reg-BundleSize Resource Element Groups (REGs) can be bundled to create REG bundles. This parameter defines the size of such bundles (see TS 38.211 [16], clause 7.3.2.2).
shiftIndex When the field is absent the UE applies the value of the *physCellId*configured for this serving cell (see TS 38.211 [16], clause 7.3.2.2).
tci-PresentInDCI This field indicates if TCI field is present or absent in DL-related DCI. When the field is absent the UE considers the TCI to be absent/disabled. In case of cross carrier scheduling, the network sets this field to enabled for the *ControlResourceSet* used for cross carrier scheduling in the scheduling cell (see TS 38.214 [19], clause 5.1.5).
tci-StatesPDCCH-ToAddList A subset of the TCI states defined in pdsch-Config included in the *BWP-DownlinkDedicated* corresponding to the serving cell and to the DL BWP to which the *ControlResourceSet* belong to. They are used for providing QCL relationships between the DL RS(s) in one RS Set (TCI-State) and the PDCCH DMRS ports (see TS 38.213 [13], clause 6.). The network configures at most *maxNrofTCI-StatesPDCCH* entries.

…

6.4 RRC multiplicity and type constraint values

– Multiplicity and type constraint definitions

. . .

```
maxNrofSlots                            INTEGER ::= 320     -- Maximum number of slots in a 10 ms period
maxNrofSlots-1                          INTEGER ::= 319     -- Maximum number of slots in a 10 ms period minus 1
maxNrofPhysicalResourceBlocks           INTEGER ::= 275     -- Maximum number of PRBs
maxNrofPhysicalResourceBlocks-1         INTEGER ::= 274     -- Maximum number of PRBs minus 1
maxNrofPhysicalResourceBlocksPlus1      INTEGER ::= 276     -- Maximum number of PRBs plus 1
maxNrofControlResourceSets-1            INTEGER ::= 11      -- Max number of CoReSets configurable on a serving cell minus 1
maxCoReSetDuration                      INTEGER ::= 3       -- Max number of OFDM symbols in a control resource set
maxNrofSearchSpaces-1                   INTEGER ::= 39      -- Max number of Search Spaces minus 1
maxSFI-DCI-PayloadSize                  INTEGER ::= 128     -- Max number payload of a DCI scrambled with SFI-RNTI
maxSFI-DCI-PayloadSize-1                INTEGER ::= 127     -- Max number payload of a DCI scrambled with SFI-RNTI minus 1
maxINT-DCI-PayloadSize                  INTEGER ::= 126     -- Max number payload of a DCI scrambled with INT-RNTI
maxINT-DCI-PayloadSize-1                INTEGER ::= 125     -- Max number payload of a DCI scrambled with INT-RNTI minus 1
maxNrofRateMatchPatterns                INTEGER ::= 4       -- Max number of rate matching patterns that may be configured
```

```
maxNrofRateMatchPatterns-1              INTEGER ::= 3       -- Max number of rate matching patterns that may be configured minus 1
maxNrofRateMatchPatternsPerGroup        INTEGER ::= 8       -- Max number of rate matching patterns that may be configured in one group
maxNrofCSI-ReportConfigurations         INTEGER ::= 48      -- Maximum number of report configurations
maxNrofCSI-ReportConfigurations-1       INTEGER ::= 47      -- Maximum number of report configurations minus 1
maxNrofCSI-ResourceConfigurations       INTEGER ::= 112     -- Maximum number of resource configurations
maxNrofCSI-ResourceConfigurations-1     INTEGER ::= 111     -- Maximum number of resource configurations minus 1
maxNrofAP-CSI-RS-ResourcesPerSet        INTEGER ::= 16
maxNrOfCSI-AperiodicTriggers            INTEGER ::= 128     -- Maximum number of triggers for aperiodic CSI reporting
maxNrofReportConfigPerAperiodicTrigger  INTEGER ::= 16      -- Maximum number of report configurations per trigger state for aperiodic
                                                            -- reporting
```

93. Accordingly, as illustrated above, the Samsung 5G Accused Products directly infringe one or more claims of the '658 Patent. Samsung makes, uses, sells, offers for sale, and/or imports, in this District and/or elsewhere in the United States, the Samsung 5G Accused Products and thus directly infringes the '658 Patent.

94. Samsung has also indirectly infringed and continues to indirectly infringe the '658 Patent, as provided in 35 U.S.C. § 271(b), including at least by inducing infringement by others, such as Samsung's customers and end-users, in this District and elsewhere in the United States, to use the Samsung 5G Accused Products in manners that infringe the '658 Patent. For example,

Samsung's customers and end-users directly infringe via their use of the Samsung 5G Accused Products to access and use 5G wireless technologies, infringing the '658 Patent. Samsung induces such direct infringement through its affirmative acts of making, using, selling, offering to sell, and/or importing the Samsung 5G Accused Products, as well as by advertising its 5G wireless technologies and providing instructions, documentation, and other information to its customers and end-users to encourage and teach them how to use the infringing 5G wireless technologies, including but not limited to by Samsung providing in-store and online technical support, marketing materials, product manuals, advertisements, and other product documentation. Samsung performs these affirmative acts with knowledge of the '658 Patent and with the intent, or willful blindness, that the induced acts directly infringe the '658 Patent.

95. Samsung has also indirectly infringed and continues to indirectly infringe the '658 Patent, as provided by 35 U.S.C. § 271(c), by contributing to direct infringement committed by others, such as Samsung's customers and end-users, in this District and elsewhere in the United States. Samsung's affirmative acts of selling and offering to sell the Samsung 5G Accused Products in this District and elsewhere in the United States, and causing the Samsung 5G Accused Products to be manufactured, used, sold, and offered for sale, contribute to Samsung's customers and end-users using the Samsung 5G Accused Products, such that the '658 Patent is directly infringed. The accused components in the Samsung 5G Accused Products are material to the inventions claimed in the '658 Patent, are not staple articles or commodities of commerce, have no substantial non-infringing uses, and are known by Samsung to be especially made or adapted for use in the infringement of the '658 Patent. Samsung performs these affirmative acts with knowledge of the '658 Patent and with the intent, or willful blindness, that they cause direct infringement of the '658 Patent.

96. Samsung has also infringed and continues to infringe the '658 Patent, as provided by 35 U.S.C. § 271(f)(1), by supplying or causing to be supplied in or from the United States all

or a substantial portion of the components of the Samsung 5G Accused Products, uncombined in whole or in part, in such a manner as to actively induce their combination outside the United States in a manner that would infringe the '658 Patent if such combination occurred within the United States. Samsung has likewise infringed and continues to infringe the '658 Patent, as provided by 35 U.S.C. § 271(f)(2), by supplying or causing to be supplied in or from the United States components of the Samsung 5G Accused Products that are especially made or especially adapted for infringement of the '658 Patent. The accused components in the Samsung 5G Accused Products are material to the inventions claimed in the '658 Patent, are not staple articles or commodities of commerce, have no substantial non-infringing uses, and are known by Samsung to be especially made or adapted for use in the infringement of the '658 Patent. Samsung performs these affirmative acts with knowledge of the '658 Patent and with the intent, or willful blindness, that they cause direct infringement of the '658 Patent.

97. Samsung's infringement of the '658 Patent has damaged and will continue to damage the Plaintiffs.

98. Samsung has had knowledge of the '658 Patent, and its infringement thereof, at least since June 22, 2023, when Plaintiffs provided Samsung notice that it is infringing the '658 Patent. Samsung continues without license to make, use, sell, offer to sell, and/or import the Samsung 5G Accused Products, willfully continuing Samsung's infringement.

COUNT IV: INFRINGEMENT OF THE '759 PATENT

99. Plaintiffs incorporate by reference the preceding paragraphs as though fully set forth herein.

100. U.S. Patent No. 10,785,759 ("the '759 Patent") was duly and legally issued on September 22, 2020, for an invention titled, "Method And Apparatus For Determining Numerology Bandwidth In A Wireless Communication System."

101. Plaintiffs own all rights to the '759 Patent that are necessary to bring this action.

102. Samsung is not currently licensed to practice the '759 Patent.

103. Samsung infringes, contributes to the infringement of, and/or induces infringement of the '759 Patent by making, using, selling, offering for sale, and/or importing the Samsung 5G Accused Products in/into the United States.

104. For example and as shown below, the Samsung 5G Accused Products infringe at least claim 1 of the '759 Patent by virtue of their compatibility with and practice of the 5G Standard. For example, and to the extent the preamble is limiting, the Samsung 5G Accused Products practice a method for determining numerology bandwidth. For example, this functionality is described in the 5G Standard, including but not limited to in 3GPP TS 38.214 section 5 and 3GPP TS 38.211 section 4.

<u>3GPP TS 38.214</u>

5.1.2.2 Resource allocation in frequency domain

Two downlink resource allocation schemes, type 0 and type 1, are supported. The UE shall assume that when the scheduling grant is received with DCI format 1_0, then downlink resource allocation type 1 is used.

If the scheduling DCI is configured to indicate the downlink resource allocation type as part of the *Frequency domain resource assignment* field by setting a higher layer parameter *resourceAllocation* in *pdsch-Config* to 'dynamicswitch', the UE shall use downlink resource allocation type 0 or type 1 as defined by this DCI field. Otherwise the UE shall use the downlink frequency resource allocation type as defined by the higher layer parameter *resourceAllocation*.

If a bandwidth part indicator field is not configured in the scheduling DCI or the UE does not support active BWP change via DCI, the RB indexing for downlink type 0 and type 1 resource allocation is determined within the UE's active bandwidth part. If a bandwidth part indicator field is configured in the scheduling DCI and the UE supports active BWP change via DCI, the RB indexing for downlink type 0 and type 1 resource allocation is determined within the UE's bandwidth part indicated by bandwidth part indicator field value in the DCI. The UE shall upon detection of PDCCH intended for the UE determine first the downlink bandwidth part and then the resource allocation within the bandwidth part.

For a PDSCH scheduled with a DCI format 1_0 in any type of PDCCH common search space, regardless of which bandwidth part is the active bandwidth part, RB numbering starts from the lowest RB of the CORESET in which the DCI was received; otherwise RB numbering starts from the lowest RB in the determined downlink bandwidth part.

<u>3GPP TS 38.211</u>

4.2 Numerologies

Multiple OFDM numerologies are supported as given by Table 4.2-1 where μ and the cyclic prefix for a bandwidth part are obtained from the higher-layer parameter *subcarrierSpacing* and *cyclicPrefix*, respectively.

Table 4.2-1: Supported transmission numerologies.

μ	$\Delta f = 2^{\mu} \cdot 15\,[\text{kHz}]$	Cyclic prefix
0	15	Normal
1	30	Normal
2	60	Normal, Extended
3	120	Normal
4	240	Normal

105. The Samsung 5G Accused Products further practice the step of receiving, by a user equipment (UE), information for a first numerology associated with a first subcarrier spacing, wherein the information comprises a first frequency location and a first bandwidth for the first numerology for a physical downlink shared channel (PDSCH) or a physical uplink shared channel (PUSCH). For example, this functionality is described in the 5G Standard, including but not limited to in 3GPP TS 38.331 section 6, 3GPP TS 38.213 section 12, 3GPP TS 38.211 section 4, and 3GPP TS 38.214 sections 5 and 6.

<u>3GPP TS 38.331</u>

6.2.2 Message definitions

. . .

– *RRCReconfiguration*

The *RRCReconfiguration* message is the command to modify an RRC connection. It may convey information for measurement configuration, mobility control, radio resource configuration (including RBs, MAC main configuration and physical channel configuration) and AS security configuration.

Signalling radio bearer: SRB1 or SRB3

RLC-SAP: AM

Logical channel: DCCH

Direction: Network to UE

RRCReconfiguration message

```
-- ASN1START
-- TAG-RRCRECONFIGURATION-START

RRCReconfiguration ::=              SEQUENCE {
    rrc-TransactionIdentifier           RRC-TransactionIdentifier,
    criticalExtensions                  CHOICE {
        rrcReconfiguration                  RRCReconfiguration-IEs,
        criticalExtensionsFuture            SEQUENCE {}
    }
}

RRCReconfiguration-IEs ::=          SEQUENCE {
    radioBearerConfig                       RadioBearerConfig                                   OPTIONAL, -- Need M
    secondaryCellGroup                      OCTET STRING (CONTAINING CellGroupConfig)           OPTIONAL, -- Need M
    measConfig                              MeasConfig                                          OPTIONAL, -- Need M
    lateNonCriticalExtension                OCTET STRING                                        OPTIONAL,
    nonCriticalExtension                    RRCReconfiguration-v1530-IEs                        OPTIONAL
}
```

. . .

***RRCSetup* message**

```
-- ASN1START
-- TAG-RRCSETUP-START

RRCSetup ::=                        SEQUENCE {
    rrc-TransactionIdentifier           RRC-TransactionIdentifier,
    criticalExtensions                  CHOICE {
        rrcSetup                            RRCSetup-IEs,
        criticalExtensionsFuture            SEQUENCE {}
    }
}

RRCSetup-IEs ::=                    SEQUENCE {
    radioBearerConfig                   RadioBearerConfig,
    masterCellGroup                     OCTET STRING (CONTAINING CellGroupConfig),

    lateNonCriticalExtension            OCTET STRING                                        OPTIONAL,
    nonCriticalExtension                SEQUENCE{}                                          OPTIONAL
}

-- TAG-RRCSETUP-STOP
-- ASN1STOP
```

. . .

6.3.2 Radio resource control information elements

. . .

– *CellGroupConfig*

The *CellGroupConfig* IE is used to configure a master cell group (MCG) or secondary cell group (SCG). A cell group comprises of one MAC entity, a set of logical channels with associated RLC entities and of a primary cell (SpCell) and one or more secondary cells (SCells).

***CellGroupConfig* information element**

```
-- ASN1START
-- TAG-CELLGROUPCONFIG-START

-- Configuration of one Cell-Group:
CellGroupConfig ::=                 SEQUENCE {
    cellGroupId                         CellGroupId,

    rlc-BearerToAddModList              SEQUENCE (SIZE(1..maxLC-ID)) OF RLC-BearerConfig        OPTIONAL,   -- Need N
    rlc-BearerToReleaseList             SEQUENCE (SIZE(1..maxLC-ID)) OF LogicalChannelIdentity  OPTIONAL,   -- Need N

    mac-CellGroupConfig                 MAC-CellGroupConfig                                     OPTIONAL,   -- Need M

    physicalCellGroupConfig             PhysicalCellGroupConfig                                 OPTIONAL,   -- Need M

    spCellConfig                        SpCellConfig                                            OPTIONAL,   -- Need M
    sCellToAddModList                   SEQUENCE (SIZE (1..maxNrofSCells)) OF SCellConfig       OPTIONAL,   -- Need N
    sCellToReleaseList                  SEQUENCE (SIZE (1..maxNrofSCells)) OF SCellIndex        OPTIONAL,   -- Need N
    ...,
    [[
    reportUplinkTxDirectCurrent         ENUMERATED {true}                                       OPTIONAL    -- Cond BWP-Reconfig
    ]]
}

-- Serving cell specific MAC and PHY parameters for a SpCell:
SpCellConfig ::=                    SEQUENCE {
    servCellIndex                       ServCellIndex                                   OPTIONAL,   -- Cond SCG
    reconfigurationWithSync             ReconfigurationWithSync                         OPTIONAL,   -- Cond ReconfWithSync
```

```
    rlf-TimersAndConstants              SetupRelease { RLF-TimersAndConstants }                OPTIONAL,    -- Need M
    rlmInSyncOutOfSyncThreshold         ENUMERATED {n1}                                        OPTIONAL,    -- Need S
    spCellConfigDedicated               ServingCellConfig                                      OPTIONAL,    -- Need M
    ...
}

ReconfigurationWithSync ::=         SEQUENCE {
    spCellConfigCommon                  ServingCellConfigCommon                                    OPTIONAL,    -- Need M
    newUE-Identity                      RNTI-Value,
    t304                                ENUMERATED {ms50, ms100, ms150, ms200, ms500, ms1000, ms2000, ms10000},
    rach-ConfigDedicated                CHOICE {
        uplink                              RACH-ConfigDedicated,
        supplementaryUplink                 RACH-ConfigDedicated
    }                                                                                          OPTIONAL,    -- Need N
    ...,
    [[
    smtc                                SSB-MTC                                                OPTIONAL     -- Need S
    ]]
}

SCellConfig ::=                     SEQUENCE {
    sCellIndex                          SCellIndex,
    sCellConfigCommon                   ServingCellConfigCommon                                OPTIONAL,    -- Cond SCellAdd
    sCellConfigDedicated                ServingCellConfig                                      OPTIONAL,    -- Cond SCellAddMod
    ...,
    [[
    smtc                                SSB-MTC                                                OPTIONAL     -- Need S
    ]]
}

-- TAG-CELLGROUPCONFIG-STOP
-- ASN1STOP
```

. . .

– *ServingCellConfig*

The IE *ServingCellConfig* is used to configure (add or modify) the UE with a serving cell, which may be the SpCell or an SCell of an MCG or SCG. The parameters herein are mostly UE specific but partly also cell specific (e.g. in additionally configured bandwidth parts). Reconfiguration between a PUCCH and PUCCHless SCell is only supported using an SCell release and add.

***ServingCellConfig* information element**

```
-- ASN1START
-- TAG-SERVINGCELLCONFIG-START

ServingCellConfig ::=               SEQUENCE {
    tdd-UL-DL-ConfigurationDedicated    TDD-UL-DL-ConfigDedicated                              OPTIONAL,    -- Cond TDD
    initialDownlinkBWP                  BWP-DownlinkDedicated                                  OPTIONAL,    -- Need M
    downlinkBWP-ToReleaseList           SEQUENCE (SIZE (1..maxNrofBWPs)) OF BWP-Id             OPTIONAL,    -- Need N
    downlinkBWP-ToAddModList            SEQUENCE (SIZE (1..maxNrofBWPs)) OF BWP-Downlink       OPTIONAL,    -- Need N
    firstActiveDownlinkBWP-Id           BWP-Id                                                 OPTIONAL,    -- Cond SyncAndCellAdd
    bwp-InactivityTimer                 ENUMERATED {ms2, ms3, ms4, ms5, ms6, ms8, ms10, ms20, ms30,
                                                    ms40,ms50, ms60, ms80,ms100, ms200,ms300, ms500,
                                                    ms750, ms1280, ms1920, ms2560, spare10, spare9, spare8,
                                                    spare7, spare6, spare5, spare4, spare3, spare2, spare1 }   OPTIONAL,   --Need R
    defaultDownlinkBWP-Id               BWP-Id                                                     OPTIONAL,   -- Need S
    uplinkConfig                        UplinkConfig                                               OPTIONAL,   -- Need M
    supplementaryUplink                 UplinkConfig                                               OPTIONAL,   -- Need M
    pdcch-ServingCellConfig             SetupRelease { PDCCH-ServingCellConfig }                   OPTIONAL,   -- Need M
    pdsch-ServingCellConfig             SetupRelease { PDSCH-ServingCellConfig }                   OPTIONAL,   -- Need M
    csi-MeasConfig                      SetupRelease { CSI-MeasConfig }                            OPTIONAL,   -- Need M
    sCellDeactivationTimer              ENUMERATED {ms20, ms40, ms80, ms160, ms200, ms240,
                                                    ms320, ms400, ms480, ms520, ms640, ms720,
                                                    ms840, ms1280, spare2,spare1}        OPTIONAL,    -- Cond ServingCellWithoutPUCCH
    crossCarrierSchedulingConfig        CrossCarrierSchedulingConfig                           OPTIONAL,    -- Need M
    tag-Id                              TAG-Id,
    dummy                               ENUMERATED {enabled}                                   OPTIONAL,    -- Need R
    pathlossReferenceLinking            ENUMERATED {spCell, sCell}                              OPTIONAL,    -- Cond SCellOnly
    servingCellMO                       MeasObjectId                                           OPTIONAL,    -- Cond MeasObject
    ...,
    [[
    lte-CRS-ToMatchAround               SetupRelease { RateMatchPatternLTE-CRS }                   OPTIONAL,   -- Need M
    rateMatchPatternToAddModList        SEQUENCE (SIZE (1..maxNrofRateMatchPatterns)) OF RateMatchPattern      OPTIONAL,   -- Need N
    rateMatchPatternToReleaseList       SEQUENCE (SIZE (1..maxNrofRateMatchPatterns)) OF RateMatchPatternId    OPTIONAL,   -- Need N
```

```
    downlinkChannelBW-PerSCS-List       SEQUENCE (SIZE (1..maxSCSs)) OF SCS-SpecificCarrier            OPTIONAL     -- Need S
    ]]
}

UplinkConfig ::=                    SEQUENCE {
    initialUplinkBWP                    BWP-UplinkDedicated                                    OPTIONAL,    -- Need M
    uplinkBWP-ToReleaseList             SEQUENCE (SIZE (1..maxNrofBWPs)) OF BWP-Id             OPTIONAL,    -- Need N
    uplinkBWP-ToAddModList              SEQUENCE (SIZE (1..maxNrofBWPs)) OF BWP-Uplink         OPTIONAL,    -- Need N
    firstActiveUplinkBWP-Id             BWP-Id                                                 OPTIONAL,    -- Cond SyncAndCellAdd
    pusch-ServingCellConfig             SetupRelease { PUSCH-ServingCellConfig }               OPTIONAL,    -- Need M
    carrierSwitching                    SetupRelease { SRS-CarrierSwitching }                  OPTIONAL,    -- Need M
    ...,
    [[
    powerBoostPi2BPSK                   BOOLEAN                                                OPTIONAL,    -- Need M
    uplinkChannelBW-PerSCS-List         SEQUENCE (SIZE (1..maxSCSs)) OF SCS-SpecificCarrier    OPTIONAL     -- Need S
    ]]
}

-- TAG-SERVINGCELLCONFIG-STOP
-- ASN1STOP
```

. . .

– *BWP*

The IE *BWP* is used to configure generic parameters of a bandwidth part as defined in TS 38.211 [16], clause 4.5, and TS 38.213 [13], clause 12.

For each serving cell the network configures at least an initial downlink bandwidth part and one (if the serving cell is configured with an uplink) or two (if using supplementary uplink (SUL)) initial uplink bandwidth parts. Furthermore, the network may configure additional uplink and downlink bandwidth parts for a serving cell.

The uplink and downlink bandwidth part configurations are divided into common and dedicated parameters.

BWP **information element**

```
-- ASN1START
-- TAG-BWP-START

BWP ::=                             SEQUENCE {
    locationAndBandwidth                INTEGER (0..37949),
    subcarrierSpacing                   SubcarrierSpacing,
    cyclicPrefix                        ENUMERATED { extended }                                 OPTIONAL    -- Need R
}

-- TAG-BWP-STOP
-- ASN1STOP
```

BWP **field descriptions**
cyclicPrefix Indicates whether to use the extended cyclic prefix for this bandwidth part. If not set, the UE uses the normal cyclic prefix. Normal CP is supported for all subcarrier spacings and slot formats. Extended CP is supported only for 60 kHz subcarrier spacing. (see TS 38.211 [16], clause 4.2)
locationAndBandwidth Frequency domain location and bandwidth of this bandwidth part. The value of the field shall be interpreted as resource indicator value (RIV) as defined TS 38.214 [19] with assumptions as described in TS 38.213 [13], clause 12, i.e. setting N_{BWP}^{size}=275. The first PRB is a PRB determined by *subcarrierSpacing* of this BWP and *offsetToCarrier* (configured in *SCS-SpecificCarrier* contained within *FrequencyInfoDL* / *FrequencyInfoUL* / *FrequencyInfoUL-SIB* / *FrequencyInfoDL-SIB* within *ServingCellConfigCommon* / *ServingCellConfigCommonSIB*) corresponding to this subcarrier spacing. In case of TDD, a BWP-pair (UL BWP and DL BWP with the same *bwp-Id*) must have the same center frequency (see TS 38.213 [13], clause 12)
subcarrierSpacing Subcarrier spacing to be used in this BWP for all channels and reference signals unless explicitly configured elsewhere. Corresponds to subcarrier spacing according to TS 38.211 [16], table 4.2-1. The value *kHz15* corresponds to μ=0, value *kHz30* corresponds to μ=1, and so on. Only the values 15 kHz, 30 kHz, or 60 kHz (FR1), and 60 kHz or 120 kHz (FR2) are applicable. For the initial DL BWP this field has the same value as the field *subCarrierSpacingCommon* in *MIB* of the same serving cell.

– *BWP-Downlink*

The IE *BWP-Downlink* is used to configure an additional downlink bandwidth part (not for the initial BWP).

BWP-Downlink **information element**

```
-- ASN1START
-- TAG-BWP-DOWNLINK-START

BWP-Downlink ::=                    SEQUENCE {
    bwp-Id                              BWP-Id,
    bwp-Common                          BWP-DownlinkCommon                          OPTIONAL,   -- Cond SetupOtherBWP
    bwp-Dedicated                       BWP-DownlinkDedicated                       OPTIONAL,   -- Cond SetupOtherBWP
    ...
}

-- TAG-BWP-DOWNLINK-STOP
-- ASN1STOP
```

BWP-Downlink **field descriptions**
bwp-Id An identifier for this bandwidth part. Other parts of the RRC configuration use the *BWP-Id* to associate themselves with a particular bandwidth part. The network configures the BWPs with consecutive IDs from 1. The Network does not include the value 0, since value 0 is reserved for the initial BWP.

Conditional Presence	**Explanation**
SetupOtherBWP	The field is mandatory present upon configuration of a new DL BWP. The field is optionally present, Need M, otherwise.

– *BWP-DownlinkCommon*

The IE *BWP-DownlinkCommon* is used to configure the common parameters of a downlink BWP. They are "cell specific" and the network ensures the necessary alignment with corresponding parameters of other UEs. The common parameters of the initial bandwidth part of the PCell are also provided via system information. For all other serving cells, the network provides the common parameters via dedicated signalling.

BWP-DownlinkCommon **information element**

```
-- ASN1START
-- TAG-BWP-DOWNLINKCOMMON-START

BWP-DownlinkCommon ::=              SEQUENCE {
    genericParameters                   BWP,
    pdcch-ConfigCommon                  SetupRelease { PDCCH-ConfigCommon }             OPTIONAL,   -- Need M
    pdsch-ConfigCommon                  SetupRelease { PDSCH-ConfigCommon }             OPTIONAL,   -- Need M
    ...
}

-- TAG-BWP-DOWNLINKCOMMON-STOP
-- ASN1STOP
```

BWP-DownlinkCommon **field descriptions**
pdcch-ConfigCommon Cell specific parameters for the PDCCH of this BWP.
pdsch-ConfigCommon Cell specific parameters for the PDSCH of this BWP.

– *BWP-Uplink*

The IE *BWP-Uplink* is used to configure an additional uplink bandwidth part (not for the initial BWP).

BWP-Uplink **information element**

```
-- ASN1START
-- TAG-BWP-UPLINK-START

BWP-Uplink ::=                      SEQUENCE {
    bwp-Id                              BWP-Id,
    bwp-Common                          BWP-UplinkCommon                                        OPTIONAL,   -- Cond SetupOtherBWP
    bwp-Dedicated                       BWP-UplinkDedicated                                     OPTIONAL,   -- Cond SetupOtherBWP
    ...
}

-- TAG-BWP-UPLINK-STOP
-- ASN1STOP
```

BWP-Uplink **field descriptions**
bwp-Id An identifier for this bandwidth part. Other parts of the RRC configuration use the *BWP-Id* to associate themselves with a particular bandwidth part. The network configures the BWPs with consecutive IDs from 1. The Network does not include the value 0, since value 0 is reserved for the initial BWP.

Conditional Presence	Explanation
SetupOtherBWP	The field is mandatory present upon configuration of a new UL BWP. The field is optionally present, Need M, otherwise.

– *BWP-UplinkCommon*

The IE *BWP-UplinkCommon* is used to configure the common parameters of an uplink BWP. They are "cell specific" and the network ensures the necessary alignment with corresponding parameters of other UEs. The common parameters of the initial bandwidth part of the PCell are also provided via system information. For all other serving cells, the network provides the common parameters via dedicated signalling.

BWP-UplinkCommon **information element**

```
-- ASN1START
-- TAG-BWP-UPLINKCOMMON-START

BWP-UplinkCommon ::=                SEQUENCE {
    genericParameters                   BWP,
    rach-ConfigCommon                   SetupRelease { RACH-ConfigCommon }                      OPTIONAL,   -- Need M
    pusch-ConfigCommon                  SetupRelease { PUSCH-ConfigCommon }                     OPTIONAL,   -- Need M
    pucch-ConfigCommon                  SetupRelease { PUCCH-ConfigCommon }                     OPTIONAL,   -- Need M
    ...
}

-- TAG-BWP-UPLINKCOMMON-STOP
-- ASN1STOP
```

BWP-UplinkCommon **field descriptions**
pucch-ConfigCommon Cell specific parameters for the PUCCH of this BWP.
pusch-ConfigCommon Cell specific parameters for the PUSCH of this BWP.
rach-ConfigCommon Configuration of cell specific random access parameters which the UE uses for contention based and contention free random access as well as for contention based beam failure recovery in this BWP. The NW configures SSB-based RA (and hence *RACH-ConfigCommon*) only for UL BWPs if the linked DL BWPs (same *bwp-Id* as UL-BWP) are the initial DL BWPs or DL BWPs containing the SSB associated to the initial DL BWP. The network configures *rach-ConfigCommon*, whenever it configures contention free random access (for reconfiguration with sync or for beam failure recovery).

. . .

– *SCS-SpecificCarrier*

The IE *SCS-SpecificCarrier* provides parameters determining the location and width of the actual carrier or the carrier bandwidth. It is defined specifically for a numerology (subcarrier spacing (SCS)) and in relation (frequency offset) to Point A.

***SCS-SpecificCarrier* information element**

```
-- ASN1START
-- TAG-SCS-SPECIFICCARRIER-START

SCS-SpecificCarrier ::=         SEQUENCE {
    offsetToCarrier                 INTEGER (0..2199),
    subcarrierSpacing               SubcarrierSpacing,
    carrierBandwidth                INTEGER (1..maxNrofPhysicalResourceBlocks),
    ...,
    [[
    txDirectCurrentLocation     INTEGER (0..4095)                  OPTIONAL        -- Need S
    ]]
}

-- TAG-SCS-SPECIFICCARRIER-STOP
-- ASN1STOP
```

***SCS-SpecificCarrier* field descriptions**
carrierBandwidth Width of this carrier in number of PRBs (using the *subcarrierSpacing* defined for this carrier) (see TS 38.211 [16], clause 4.4.2).
offsetToCarrier Offset in frequency domain between Point A (lowest subcarrier of common RB 0) and the lowest usable subcarrier on this carrier in number of PRBs (using the subcarrierSpacing defined for this carrier). The maximum value corresponds to 275*8-1. See TS 38.211 [16], clause 4.4.2.
txDirectCurrentLocation Indicates the downlink Tx Direct Current location for the carrier. A value in the range 0..3299 indicates the subcarrier index within the carrier. The values in the value range 3301..4095 are reserved and ignored by the UE. If this field is absent for downlink within *ServingCellConfigCommon* and *ServingCellConfigCommonSIB*, the UE assumes the default value of 3300 (i.e. "Outside the carrier"). (see TS 38.211 [16], clause 4.4.2). Network does not configure this field via *ServingCellConfig* or for uplink carriers.
subcarrierSpacing Subcarrier spacing of this carrier. It is used to convert the offsetToCarrier into an actual frequency. Only the values 15 kHz, 30 kHz or 60 kHz (FR1), and 60 kHz or 120 kHz (FR2) are applicable.

<u>3GPP TS 38.213</u>

12 Bandwidth part operation

. . .

For each DL BWP or UL BWP in a set of DL BWPs or UL BWPs, respectively, the UE is provided the following parameters for the serving cell as defined in [4, TS 38.211] or [6, TS 38.214]:

- a SCS by *subcarrierSpacing*
- a cyclic prefix by *cyclicPrefix*
- a common RB $N_{\text{BWP}}^{\text{start}} = O_{\text{carrier}} + RB_{\text{start}}$ and a number of contiguous RBs $N_{\text{BWP}}^{\text{size}} = L_{\text{RB}}$ provided by *locationAndBandwidth* that indicates an offset RB_{start} and a length L_{RB} as RIV according to [6, TS 38.214], setting $N_{\text{BWP}}^{\text{size}} = 275$, and a value O_{carrier} provided by *offsetToCarrier* for the *subcarrierSpacing*
- an index in the set of DL BWPs or UL BWPs by respective *BWP-Id*
- a set of BWP-common and a set of BWP-dedicated parameters by *BWP-DownlinkCommon* and *BWP-DownlinkDedicated* for the DL BWP, or *BWP-UplinkCommon* and *BWP-UplinkDedicated* for the UL BWP [12, TS 38.331]

. . .

A UE receives PDCCH and PDSCH in a DL BWP according to a configured SCS and CP length for the DL BWP. A UE transmits PUCCH and PUSCH in an UL BWP according to a configured SCS and CP length for the UL BWP.

3GPP TS 38.211

4.4.5 Bandwidth part

A bandwidth part is a subset of contiguous common resource blocks defined in subclause 4.4.4.3 for a given numerology μ_i in bandwidth part i on a given carrier. The starting position $N_{\mathrm{BWP},i}^{\mathrm{start},\mu}$ and the number of resource blocks $N_{\mathrm{BWP},i}^{\mathrm{size},\mu}$ in a bandwidth part shall fulfil $N_{\mathrm{grid},x}^{\mathrm{start},\mu} \leq N_{\mathrm{BWP},i}^{\mathrm{start},\mu} < N_{\mathrm{grid},x}^{\mathrm{start},\mu} + N_{\mathrm{grid},x}^{\mathrm{size},\mu}$ and $N_{\mathrm{grid},x}^{\mathrm{start},\mu} < N_{\mathrm{BWP},i}^{\mathrm{start},\mu} + N_{\mathrm{BWP},i}^{\mathrm{size},\mu} \leq N_{\mathrm{grid},x}^{\mathrm{start},\mu} + N_{\mathrm{grid},x}^{\mathrm{size},\mu}$, respectively. Configuration of a bandwidth part is described in clause 12 of [5, TS 38.213].

A UE can be configured with up to four bandwidth parts in the downlink with a single downlink bandwidth part being active at a given time. The UE is not expected to receive PDSCH, PDCCH, or CSI-RS (except for RRM) outside an active bandwidth part.

3GPP TS 38.214

5.1.2.2 Resource allocation in frequency domain

Two downlink resource allocation schemes, type 0 and type 1, are supported. The UE shall assume that when the scheduling grant is received with DCI format 1_0, then downlink resource allocation type 1 is used.

If the scheduling DCI is configured to indicate the downlink resource allocation type as part of the *Frequency domain resource assignment* field by setting a higher layer parameter *resourceAllocation* in *pdsch-Config* to 'dynamicswitch', the UE shall use downlink resource allocation type 0 or type 1 as defined by this DCI field. Otherwise the UE shall use the downlink frequency resource allocation type as defined by the higher layer parameter *resourceAllocation*.

If a bandwidth part indicator field is not configured in the scheduling DCI or the UE does not support active BWP change via DCI, the RB indexing for downlink type 0 and type 1 resource allocation is determined within the UE's active bandwidth part. If a bandwidth part indicator field is configured in the scheduling DCI and the UE supports active BWP change via DCI, the RB indexing for downlink type 0 and type 1 resource allocation is determined within the UE's bandwidth part indicated by bandwidth part indicator field value in the DCI. The UE shall upon detection of PDCCH intended for the UE determine first the downlink bandwidth part and then the resource allocation within the bandwidth part.

For a PDSCH scheduled with a DCI format 1_0 in any type of PDCCH common search space, regardless of which bandwidth part is the active bandwidth part, RB numbering starts from the lowest RB of the CORESET in which the DCI was received; otherwise RB numbering starts from the lowest RB in the determined downlink bandwidth part.

5.1.2.2.1 Downlink resource allocation type 0

In downlink resource allocation of type 0, the resource block assignment information includes a bitmap indicating the Resource Block Groups (RBGs) that are allocated to the scheduled UE where a RBG is a set of consecutive virtual resource blocks defined by higher layer parameter *rbg-Size* configured by *PDSCH-Config* and the size of the bandwidth part as defined in Table 5.1.2.2.1-1.

Table 5.1.2.2.1-1: Nominal RBG size *P*

Bandwidth Part Size	Configuration 1	Configuration 2
1 – 36	2	4
37 – 72	4	8
73 – 144	8	16
145 – 275	16	16

The total number of RBGs (N_{RBG}) for a downlink bandwidth part i of size $N_{\mathrm{BWP},i}^{size}$ PRBs is given by

$$N_{RBG} = \left\lceil \left(N_{BWP,i}^{size} + \left(N_{BWP,i}^{start} \bmod P \right) \right) / P \right\rceil, \text{ where}$$

- the size of the first RBG is $RBG_0^{size} = P - N_{BWP,i}^{start} \bmod P$,
- the size of last RBG is $RBG_{last}^{size} = \left(N_{BWP,i}^{start} + N_{BWP,i}^{size} \right) \bmod P$ if $\left(N_{BWP,i}^{start} + N_{BWP,i}^{size} \right) \bmod P > 0$ and P otherwise,
- the size of all other RBGs is P.

The bitmap is of size N_{RBG} bits with one bitmap bit per RBG such that each RBG is addressable. The RBGs shall be indexed in the order of increasing frequency and starting at the lowest frequency of the bandwidth part. The order of RBG bitmap is such that RBG 0 to RBG $N_{\mathrm{RBG}} - 1$ are mapped from MSB to LSB. The RBG is allocated to the UE if the corresponding bit value in the bitmap is 1, the RBG is not allocated to the UE otherwise.

5.1.2.2.2 Downlink resource allocation type 1

In downlink resource allocation of type 1, the resource block assignment information indicates to a scheduled UE a set of contiguously allocated non-interleaved or interleaved virtual resource blocks within the active bandwidth part of size N_{BWP}^{size} PRBs except for the case when DCI format 1_0 is decoded in any common search space in which case the size of CORESET 0 shall be used if CORESET 0 is configured for the cell and the size of initial DL bandwidth part shall be used if CORESET 0 is not configured for the cell.

A downlink type 1 resource allocation field consists of a resource indication value (*RIV*) corresponding to a starting virtual resource block (RB_{start}) and a length in terms of contiguously allocated resource blocks L_{RBs} . The resource indication value is defined by

if $(L_{RBs} - 1) \le \left\lfloor N_{BWP}^{size} / 2 \right\rfloor$ then

$$RIV = N_{BWP}^{size}(L_{RBs} - 1) + RB_{start}$$

else

$$RIV = N_{BWP}^{size}(N_{BWP}^{size} - L_{RBs} + 1) + (N_{BWP}^{size} - 1 - RB_{start})$$

where $L_{RBs} \ge 1$ and shall not exceed $N_{BWP}^{size} - RB_{start}$.

When the DCI size for DCI format 1_0 in USS is derived from the size of DCI format 1_0 in CSS but applied to an active BWP with size of $N_{\mathrm{BWP}}^{active}$, a downlink type 1 resource block assignment field consists of a resource indication value (*RIV*) corresponding to a starting resource block $RB_{start} = 0, K, 2 \cdot K, \ldots, (N_{\mathrm{BWP}}^{initial} - 1) \cdot K$ and a length in terms of virtually contiguously allocated resource blocks $L_{RBs} = K, 2 \cdot K, \ldots, N_{\mathrm{BWP}}^{initial} \cdot K$, where $N_{\mathrm{BWP}}^{initial}$ is given by

- the size of CORESET 0 if CORESET 0 is configured for the cell;
- the size of initial DL bandwidth part if CORESET 0 is not configured for the cell.

The resource indication value is defined by:

if $(L'_{RBs} - 1) \leq \lfloor N_{BWP}^{initial} / 2 \rfloor$ then

$$RIV = N_{BWP}^{initial}(L'_{RBs} - 1) + RB'_{start}$$

else

$$RIV = N_{BWP}^{initial}(N_{BWP}^{initial} - L'_{RBs} + 1) + (N_{BWP}^{initial} - 1 - RB'_{start})$$

where $L'_{RBs} = L_{RBs} / K$, $RB'_{start} = RB_{start} / K$ and where L'_{RBs} shall not exceed $N_{BWP}^{initial} - RB'_{start}$.

If $N_{BWP}^{active} > N_{BWP}^{initial}$, K is the maximum value from set $\{1, 2, 4, 8\}$ which satisfies $K \leq \lfloor N_{BWP}^{active} / N_{BWP}^{initial} \rfloor$; otherwise $K = 1$.

. . .

6.1.2.2 Resource allocation in frequency domain

The UE shall determine the resource block assignment in frequency domain using the resource allocation field in the detected PDCCH DCI except for a PUSCH transmission scheduled by a RAR UL grant, in which case the frequency domain resource allocation is determined according to Subclause 8.3 of [6, 38.213]. Two uplink resource allocation schemes type 0 and type 1 are supported. Uplink resource allocation scheme type 0 is supported for PUSCH only when transform precoding is disabled. Uplink resource allocation scheme type 1 is supported for PUSCH for both cases when transform precoding is enabled or disabled.

If the scheduling DCI is configured to indicate the uplink resource allocation type as part of the *Frequency domain resource* assignment field by setting a higher layer parameter r*esourceAllocation* in *pusch-Config* to 'dynamicSwitch', the UE shall use uplink resource allocation type 0 or type 1 as defined by this DCI field. Otherwise the UE shall use the uplink frequency resource allocation type as defined by the higher layer parameter *resourceAllocation*.

The UE shall assume that when the scheduling PDCCH is received with DCI format 0_0, then uplink resource allocation type 1 is used.

If a bandwidth part indicator field is not configured in the scheduling DCI or the UE does not support active bandwidth part change via DCI, the RB indexing for uplink type 0 and type 1 resource allocation is determined within the UE's active bandwidth part. If a bandwidth part indicator field is configured in the scheduling DCI and the UE supports active bandwidh part change via DCI, the RB indexing for uplink type 0 and type 1 resource allocation is determined within the UE's bandwidth part indicated by bandwidth part indicator field value in the DCI. The UE shall upon detection of PDCCH intended for the UE determine first the uplink bandwidth part and then the resource allocation within the bandwidth part. RB numbering starts from the lowest RB in the determined uplink bandwidth part.

6.1.2.2.1 Uplink resource allocation type 0

In uplink resource allocation of type 0, the resource block assignment information includes a bitmap indicating the Resource Block Groups (RBGs) that are allocated to the scheduled UE where a RBG is a set of consecutive virtual resource blocks defined by higher layer parameter *rbg-Size* configured in *pusch-Config* and the size of the bandwidth part as defined in Table 6.1.2.2.1-1.

Table 6.1.2.2.1-1: Nominal RBG size *P*

Bandwidth Part Size	Configuration 1	Configuration 2
1 – 36	2	4
37 – 72	4	8
73 – 144	8	16
145 – 275	16	16

The total number of RBGs (N_{RBG}) for a uplink bandwidth part *i* of size $N_{\mathrm{BWP,i}}^{size}$ PRBs is given by

$$N_{RBG} = \left\lceil \left(N_{BWP,i}^{size} + \left(N_{BWP,i}^{start} \bmod P \right) \right) / P \right\rceil$$ where

- the size of the first RBG is $RBG_0^{size} = P - N_{BWP,i}^{start} \bmod P$,
- the size of the last RBG is $RBG_{last}^{size} = \left(N_{BWP,i}^{start} + N_{BWP,i}^{size} \right) \bmod P$ if $\left(N_{BWP,i}^{start} + N_{BWP,i}^{size} \right) \bmod P > 0$ and P otherwise.
- the size of all other RBG is *P*.

The bitmap is of size N_{RBG} bits with one bitmap bit per RBG such that each RBG is addressable. The RBGs shall be indexed in the order of increasing frequency of the bandwidth part and starting at the lowest frequency. The order of RBG bitmap is such that RBG 0 to RBG $N_{\mathrm{RBG}} - 1$ are mapped from MSB to LSB of the bitmap. The RBG is allocated to the UE if the corresponding bit value in the bitmap is 1, the RBG is not allocated to the UE otherwise.

In frequency range 1, only 'almost contiguous allocation' defined in [8, TS 38.101-1] is allowed as non-contiguous allocation per component carrier for UL RB allocation for CP-OFDM.

In frequency range 2, non-contiguous allocation per component carrier for UL RB allocation for CP-OFDM is not supported.

6.1.2.2.2 Uplink resource allocation type 1

In uplink resource allocation of type 1, the resource block assignment information indicates to a scheduled UE a set of contiguously allocated non-interleaved virtual resource blocks within the active bandwidth part of size N_{BWP}^{size} PRBs except for the case when DCI format 0_0 is decoded in any common search space in which case the size of the initial UL bandwidth part $N_{\mathrm{BWP,0}}^{size}$ shall be used.

An uplink type 1 resource allocation field consists of a resource indication value (*RIV*) corresponding to a starting virtual resource block (RB_{start}) and a length in terms of contiguously allocated resource blocks L_{RBs} . The resource indication value is defined by

if $(L_{RBs} - 1) \le \left\lfloor N_{BWP}^{size} / 2 \right\rfloor$ then

$$RIV = N_{BWP}^{size}(L_{RBs} - 1) + RB_{start}$$

else

$$RIV = N_{BWP}^{size}(N_{BWP}^{size} - L_{RBs} + 1) + (N_{BWP}^{size} - 1 - RB_{start})$$

where $L_{RBs} \ge 1$ and shall not exceed $N_{BWP}^{size} - RB_{start}$.

When the DCI size for DCI format 0_0 in USS is derived from the initial UL BWP with size $N_{\text{BWP}}^{initial}$ but applied to another active BWP with size of N_{BWP}^{active}, an uplink type 1 resource block assignment field consists of a resource indication value (*RIV*) corresponding to a starting resource block $RB_{start} = 0, K, 2 \cdot K, \ldots, (N_{\text{BWP}}^{initial} - 1) \cdot K$ and a length in terms of virtually contiguously allocated resource blocks $L_{RBs} = K, 2 \cdot K, \ldots, N_{\text{BWP}}^{initial} \cdot K$.

The resource indication value is defined by

if $(L'_{RBs} - 1) \leq \lfloor N_{BWP}^{initial} / 2 \rfloor$ then

$$RIV = N_{BWP}^{initial}(L'_{RBs} - 1) + RB'_{start}$$

else

$$RIV = N_{BWP}^{initial}(N_{BWP}^{initial} - L'_{RBs} + 1) + (N_{BWP}^{initial} - 1 - RB'_{start})$$

where $L'_{RBs} = L_{RBs} / K$, $RB'_{start} = RB_{start} / K$ and where L'_{RBs} shall not exceed $N_{BWP}^{initial} - RB'_{start}$.

If $N_{BWP}^{active} > N_{BWP}^{initial}$, K is the maximum value from set {1, 2, 4, 8} which satisfies $K \leq \lfloor N_{BWP}^{active} / N_{BWP}^{initial} \rfloor$; otherwise $K = 1$.

106. The Samsung 5G Accused Products further practice the step of detecting a physical downlink control channel (PDCCH), wherein the PDCCH is associated with the PDSCH or the PUSCH. For example, this functionality is described in the 5G Standard, including but not limited to in 3GPP TS 38.214 sections 5 and 6.

<u>3GPP TS 38.214</u>

5.1 UE procedure for receiving the physical downlink shared channel

For downlink, a maximum of 16 HARQ processes per cell is supported by the UE. The number of processes the UE may assume will at most be used for the downlink is configured to the UE for each cell separately by higher layer parameter *nrofHARQ-ProcessesForPDSCH*, and when no configuration is provided the UE may assume a default number of 8 processes.

A UE shall upon detection of a PDCCH with a configured DCI format 1_0 or 1_1 decode the corresponding PDSCHs as indicated by that DCI. For any HARQ process ID(s) in a given scheduled cell, the UE is not expected to receive a PDSCH that overlaps in time with another PDSCH. The UE is not expected to receive another PDSCH for a given HARQ process until after the end of the expected transmission of HARQ-ACK for that HARQ process, where the timing is given by Subclause 9.2.3 of [6]. In a given scheduled cell, the UE is not expected to receive a first PDSCH in slot i, with the corresponding HARQ-ACK assigned to be transmitted in slot j, and a second PDSCH starting later than the first PDSCH with its corresponding HARQ-ACK assigned to be transmitted in a slot before slot j. For any two HARQ process IDs in a given scheduled cell, if the UE is scheduled to start receiving a first PDSCH starting in symbol j by a PDCCH ending in symbol i, the UE is not expected to be scheduled to receive a PDSCH starting earlier than the end of the first PDSCH with a PDCCH that ends later than symbol i. In a given scheduled cell, for any PDSCH corresponding to SI-RNTI, the UE is not expected to decode a re-transmission of an earlier PDSCH with a starting symbol less than N symbols after the last symbol of that PDSCH, where the value of N depends on the PDSCH subcarrier spacing configuration μ, with N=13 for μ=0, N=13 for μ=1, N=20 for μ=2, and N=24 for μ=3.

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6.1 UE procedure for transmitting the physical uplink shared channel

PUSCH transmission(s) can be dynamically scheduled by an UL grant in a DCI, or the transmission can correspond to a configured grant Type 1 or Type 2. The configured grant Type 1 PUSCH transmission is semi-statically configured to operate upon the reception of higher layer parameter of *configuredGrantConfig* including *rrc-ConfiguredUplinkGrant* without the detection of an UL grant in a DCI. The configured grant Type 2 PUSCH transmission is semi-persistently scheduled by an UL grant in a valid activation DCI according to Subclause 10.2 of [6, TS 38.213] after the reception of higher layer parameter *configuredGrantConfig* not including *rrc-ConfiguredUplinkGrant*.

For the PUSCH transmission corresponding to a configured grant, the parameters applied for the transmission are provided by *configuredGrantConfig* except for *dataScramblingIdentityPUSCH*, *txConfig*, *codebookSubset*, *maxRank*, *scaling* of *UCI-OnPUSCH,* which are provided by *pusch-Config*. If the UE is provided with *transformPrecoder* in *configuredGrantConfig*, the UE applies the higher layer parameter *tp-pi2BPSK*, if provided in *pusch-Config*, according to the procedure described in Subclause 6.1.4 for the PUSCH transmission corresponding to a configured grant.

For the PUSCH retransmission scheduled by a PDCCH with CRC scrambled by CS-RNTI with NDI=1, the parameters in *pusch-Config* are applied for the PUSCH transmission except for *p0-NominalWithoutGrant, p0-PUSCH-Alpha, powerControlLoopToUse, pathlossReferenceIndex* described in Subclause 7.1 of [6, TS 38.213], *mcs-Table, mcs-TableTransformPrecoder* described in Subclause 6.1.4.1 and *transformPrecoder* described in Subclause 6.1.3.

For a UE configured with two uplinks in a serving cell, PUSCH retransmission for a TB on the serving cell is not expected to be on a different uplink than the uplink used for the PUSCH initial transmission of that TB.

A UE shall upon detection of a PDCCH with a configured DCI format 0_0 or 0_1 transmit the corresponding PUSCH as indicated by that DCI. Upon detection of a DCI format 0_1 with "UL-SCH indicator" set to "0" and with a non-zero "CSI request" where the associated "reportQuantity" in *CSI-ReportConfig* set to "none" for all CSI report(s) triggered by "CSI request" in this DCI format 0_1, the UE ignores all fields in this DCI except the "CSI request" and the UE shall not transmit the corresponding PUSCH as indicated by this DCI format 0_1. For any HARQ process ID(s) in a given scheduled cell, the UE is not expected to transmit a PUSCH that overlaps in time with another PUSCH. For any two HARQ process IDs in a given scheduled cell, if the UE is scheduled to start a first PUSCH transmission starting in symbol *j* by a PDCCH ending in symbol *i*, the UE is not expected to be scheduled to transmit a PUSCH starting earlier than the end of the first PUSCH by a PDCCH that ends later than symbol *i*. The UE is not expected to be scheduled to transmit another PUSCH by DCI format 0_0 or 0_1 scrambled by C-RNTI or MCS-C-RNTI for a given HARQ process until after the end of the expected transmission of the last PUSCH for that HARQ process.

107. The Samsung 5G Accused Products further practice the step of deriving, by the UE, a first bandwidth portion based on the first frequency location and the first bandwidth for the first numerology. For example, this functionality is described in the 5G Standard, including but not limited to in 3GPP TS 38.331 section 6, 3GPP TS 38.213 section 12, 3GPP TS 38.211 section 4, and 3GPP TS 38.214 sections 5 and 6.

<u>3GPP TS 38.331</u>

6.3.2 Radio resource control information elements

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– *BWP*

The IE *BWP* is used to configure generic parameters of a bandwidth part as defined in TS 38.211 [16], clause 4.5, and TS 38.213 [13], clause 12.

For each serving cell the network configures at least an initial downlink bandwidth part and one (if the serving cell is configured with an uplink) or two (if using supplementary uplink (SUL)) initial uplink bandwidth parts. Furthermore, the network may configure additional uplink and downlink bandwidth parts for a serving cell.

The uplink and downlink bandwidth part configurations are divided into common and dedicated parameters.

***BWP* information element**

```
-- ASN1START
-- TAG-BWP-START

BWP ::=                             SEQUENCE {
    locationAndBandwidth                INTEGER (0..37949),
    subcarrierSpacing                   SubcarrierSpacing,
    cyclicPrefix                        ENUMERATED { extended }                              OPTIONAL    -- Need R
}

-- TAG-BWP-STOP
-- ASN1STOP
```

***BWP* field descriptions**
cyclicPrefix Indicates whether to use the extended cyclic prefix for this bandwidth part. If not set, the UE uses the normal cyclic prefix. Normal CP is supported for all subcarrier spacings and slot formats. Extended CP is supported only for 60 kHz subcarrier spacing. (see TS 38.211 [16], clause 4.2)
locationAndBandwidth Frequency domain location and bandwidth of this bandwidth part. The value of the field shall be interpreted as resource indicator value (RIV) as defined TS 38.214 [19] with assumptions as described in TS 38.213 [13], clause 12, i.e. setting N_{BWP}^{size}=275. The first PRB is a PRB determined by *subcarrierSpacing* of this BWP and *offsetToCarrier* (configured in *SCS-SpecificCarrier* contained within *FrequencyInfoDL* / *FrequencyInfoUL* / *FrequencyInfoUL-SIB* / *FrequencyInfoDL-SIB* within *ServingCellConfigCommon* / *ServingCellConfigCommonSIB*) corresponding to this subcarrier spacing. In case of TDD, a BWP-pair (UL BWP and DL BWP with the same *bwp-Id*) must have the same center frequency (see TS 38.213 [13], clause 12)
subcarrierSpacing Subcarrier spacing to be used in this BWP for all channels and reference signals unless explicitly configured elsewhere. Corresponds to subcarrier spacing according to TS 38.211 [16], table 4.2-1. The value *kHz15* corresponds to μ=0, value *kHz30* corresponds to μ=1, and so on. Only the values 15 kHz, 30 kHz, or 60 kHz (FR1), and 60 kHz or 120 kHz (FR2) are applicable. For the initial DL BWP this field has the same value as the field *subCarrierSpacingCommon* in *MIB* of the same serving cell.

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– *SCS-SpecificCarrier*

The IE *SCS-SpecificCarrier* provides parameters determining the location and width of the actual carrier or the carrier bandwidth. It is defined specifically for a numerology (subcarrier spacing (SCS)) and in relation (frequency offset) to Point A.

***SCS-SpecificCarrier* information element**

```
-- ASN1START
-- TAG-SCS-SPECIFICCARRIER-START

SCS-SpecificCarrier ::=             SEQUENCE {
    offsetToCarrier                     INTEGER (0..2199),
    subcarrierSpacing                   SubcarrierSpacing,
    carrierBandwidth                    INTEGER (1..maxNrofPhysicalResourceBlocks),
    ...,
    [[
    txDirectCurrentLocation         INTEGER (0..4095)                           OPTIONAL            -- Need S
    ]]
}

-- TAG-SCS-SPECIFICCARRIER-STOP
-- ASN1STOP
```

***SCS-SpecificCarrier* field descriptions**
carrierBandwidth Width of this carrier in number of PRBs (using the *subcarrierSpacing* defined for this carrier) (see TS 38.211 [16], clause 4.4.2).
offsetToCarrier Offset in frequency domain between Point A (lowest subcarrier of common RB 0) and the lowest usable subcarrier on this carrier in number of PRBs (using the subcarrierSpacing defined for this carrier). The maximum value corresponds to 275*8-1. See TS 38.211 [16], clause 4.4.2.
txDirectCurrentLocation Indicates the downlink Tx Direct Current location for the carrier. A value in the range 0..3299 indicates the subcarrier index within the carrier. The values in the value range 3301..4095 are reserved and ignored by the UE. If this field is absent for downlink within *ServingCellConfigCommon* and *ServingCellConfigCommonSIB*, the UE assumes the default value of 3300 (i.e. "Outside the carrier"). (see TS 38.211 [16], clause 4.4.2). Network does not configure this field via *ServingCellConfig* or for uplink carriers.
subcarrierSpacing Subcarrier spacing of this carrier. It is used to convert the offsetToCarrier into an actual frequency. Only the values 15 kHz, 30 kHz or 60 kHz (FR1), and 60 kHz or 120 kHz (FR2) are applicable.

3GPP TS 38.213

12 Bandwidth part operation

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For each DL BWP or UL BWP in a set of DL BWPs or UL BWPs, respectively, the UE is provided the following parameters for the serving cell as defined in [4, TS 38.211] or [6, TS 38.214]:

- a SCS by *subcarrierSpacing*
- a cyclic prefix by *cyclicPrefix*
- a common RB $N_{\text{BWP}}^{\text{start}} = O_{\text{carrier}} + RB_{\text{start}}$ and a number of contiguous RBs $N_{\text{BWP}}^{\text{size}} = L_{\text{RB}}$ provided by *locationAndBandwidth* that indicates an offset RB_{start} and a length L_{RB} as RIV according to [6, TS 38.214], setting $N_{\text{BWP}}^{\text{size}} = 275$, and a value O_{carrier} provided by *offsetToCarrier* for the *subcarrierSpacing*
- an index in the set of DL BWPs or UL BWPs by respective *BWP-Id*
- a set of BWP-common and a set of BWP-dedicated parameters by *BWP-DownlinkCommon* and *BWP-DownlinkDedicated* for the DL BWP, or *BWP-UplinkCommon* and *BWP-UplinkDedicated* for the UL BWP [12, TS 38.331]

. . .

A UE receives PDCCH and PDSCH in a DL BWP according to a configured SCS and CP length for the DL BWP. A UE transmits PUCCH and PUSCH in an UL BWP according to a configured SCS and CP length for the UL BWP.

<u>3GPP TS 38.211</u>

4.4.5 Bandwidth part

A bandwidth part is a subset of contiguous common resource blocks defined in subclause 4.4.4.3 for a given numerology μ_i in bandwidth part i on a given carrier. The starting position $N_{\text{BWP},i}^{\text{start},\mu}$ and the number of resource blocks $N_{\text{BWP},i}^{\text{size},\mu}$ in a bandwidth part shall fulfil $N_{\text{grid},x}^{\text{start},\mu} \leq N_{\text{BWP},i}^{\text{start},\mu} < N_{\text{grid},x}^{\text{start},\mu} + N_{\text{grid},x}^{\text{size},\mu}$ and $N_{\text{grid},x}^{\text{start},\mu} < N_{\text{BWP},i}^{\text{start},\mu} + N_{\text{BWP},i}^{\text{size},\mu} \leq N_{\text{grid},x}^{\text{start},\mu} + N_{\text{grid},x}^{\text{size},\mu}$, respectively. Configuration of a bandwidth part is described in clause 12 of [5, TS 38.213].

A UE can be configured with up to four bandwidth parts in the downlink with a single downlink bandwidth part being active at a given time. The UE is not expected to receive PDSCH, PDCCH, or CSI-RS (except for RRM) outside an active bandwidth part.

<u>3GPP TS 38.214</u>

5.1.2.2 Resource allocation in frequency domain

Two downlink resource allocation schemes, type 0 and type 1, are supported. The UE shall assume that when the scheduling grant is received with DCI format 1_0, then downlink resource allocation type 1 is used.

If the scheduling DCI is configured to indicate the downlink resource allocation type as part of the *Frequency domain resource assignment* field by setting a higher layer parameter *resourceAllocation* in *pdsch-Config* to 'dynamicswitch', the UE shall use downlink resource allocation type 0 or type 1 as defined by this DCI field. Otherwise the UE shall use the downlink frequency resource allocation type as defined by the higher layer parameter *resourceAllocation*.

If a bandwidth part indicator field is not configured in the scheduling DCI or the UE does not support active BWP change via DCI, the RB indexing for downlink type 0 and type 1 resource allocation is determined within the UE's active bandwidth part. If a bandwidth part indicator field is configured in the scheduling DCI and the UE supports active BWP change via DCI, the RB indexing for downlink type 0 and type 1 resource allocation is determined within the UE's bandwidth part indicated by bandwidth part indicator field value in the DCI. The UE shall upon detection of PDCCH intended for the UE determine first the downlink bandwidth part and then the resource allocation within the bandwidth part.

For a PDSCH scheduled with a DCI format 1_0 in any type of PDCCH common search space, regardless of which bandwidth part is the active bandwidth part, RB numbering starts from the lowest RB of the CORESET in which the DCI was received; otherwise RB numbering starts from the lowest RB in the determined downlink bandwidth part.

5.1.2.2.1 Downlink resource allocation type 0

In downlink resource allocation of type 0, the resource block assignment information includes a bitmap indicating the Resource Block Groups (RBGs) that are allocated to the scheduled UE where a RBG is a set of consecutive virtual resource blocks defined by higher layer parameter *rbg-Size* configured by *PDSCH-Config* and the size of the bandwidth part as defined in Table 5.1.2.2.1-1.

Table 5.1.2.2.1-1: Nominal RBG size *P*

Bandwidth Part Size	Configuration 1	Configuration 2
1 – 36	2	4
37 – 72	4	8
73 – 144	8	16
145 – 275	16	16

The total number of RBGs (N_{RBG}) for a downlink bandwidth part i of size $N^{size}_{\mathrm{BWP},i}$ PRBs is given by

$$N_{RBG} = \left\lceil \left(N^{size}_{BWP,i} + \left(N^{start}_{BWP,i} \bmod P \right) \right) / P \right\rceil$$, where

- the size of the first RBG is $RBG^{size}_0 = P - N^{start}_{BWP,i} \bmod P$,
- the size of last RBG is $RBG^{size}_{last} = \left(N^{start}_{BWP,i} + N^{size}_{BWP,i}\right) \bmod P$ if $\left(N^{start}_{BWP,i} + N^{size}_{BWP,i}\right) \bmod P > 0$ and P otherwise,
- the size of all other RBGs is P.

The bitmap is of size N_{RBG} bits with one bitmap bit per RBG such that each RBG is addressable. The RBGs shall be indexed in the order of increasing frequency and starting at the lowest frequency of the bandwidth part. The order of RBG bitmap is such that RBG 0 to RBG $N_{\mathrm{RBG}} - 1$ are mapped from MSB to LSB. The RBG is allocated to the UE if the corresponding bit value in the bitmap is 1, the RBG is not allocated to the UE otherwise.

5.1.2.2.2 Downlink resource allocation type 1

In downlink resource allocation of type 1, the resource block assignment information indicates to a scheduled UE a set of contiguously allocated non-interleaved or interleaved virtual resource blocks within the active bandwidth part of size N_{BWP}^{size} PRBs except for the case when DCI format 1_0 is decoded in any common search space in which case the size of CORESET 0 shall be used if CORESET 0 is configured for the cell and the size of initial DL bandwidth part shall be used if CORESET 0 is not configured for the cell.

A downlink type 1 resource allocation field consists of a resource indication value (*RIV*) corresponding to a starting virtual resource block (RB_{start}) and a length in terms of contiguously allocated resource blocks L_{RBs} . The resource indication value is defined by

if $(L_{RBs}-1) \leq \lfloor N_{BWP}^{size}/2 \rfloor$ then

$$RIV = N_{BWP}^{size}(L_{RBs}-1)+RB_{start}$$

else

$$RIV = N_{BWP}^{size}(N_{BWP}^{size}-L_{RBs}+1)+(N_{BWP}^{size}-1-RB_{start})$$

where $L_{RBs} \geq 1$ and shall not exceed $N_{BWP}^{size} - RB_{start}$.

When the DCI size for DCI format 1_0 in USS is derived from the size of DCI format 1_0 in CSS but applied to an active BWP with size of N_{BWP}^{active} , a downlink type 1 resource block assignment field consists of a resource indication value (*RIV*) corresponding to a starting resource block $RB_{start} = 0, K, 2 \cdot K, \ldots, (N_{\text{BWP}}^{initial}-1) \cdot K$ and a length in terms of virtually contiguously allocated resource blocks $L_{RBs} = K, 2 \cdot K, \ldots, N_{\text{BWP}}^{initial} \cdot K$, where $N_{\text{BWP}}^{initial}$ is given by

- the size of CORESET 0 if CORESET 0 is configured for the cell;
- the size of initial DL bandwidth part if CORESET 0 is not configured for the cell.

The resource indication value is defined by:

if $(L'_{RBs}-1) \leq \lfloor N_{BWP}^{initial}/2 \rfloor$ then

$$RIV = N_{BWP}^{initial}(L'_{RBs}-1)+RB'_{start}$$

else

$$RIV = N_{BWP}^{initial}(N_{BWP}^{initial}-L'_{RBs}+1)+(N_{BWP}^{initial}-1-RB'_{start})$$

where $L'_{RBs} = L_{RBs}/K$, $RB'_{start} = RB_{start}/K$ and where L'_{RBs} shall not exceed $N_{BWP}^{initial} - RB'_{start}$.

If $N_{BWP}^{active} > N_{BWP}^{initial}$, K is the maximum value from set {1, 2, 4, 8} which satisfies $K \leq \lfloor N_{BWP}^{active}/N_{BWP}^{initial} \rfloor$; otherwise $K = 1$.

. . .

6.1.2.2 Resource allocation in frequency domain

The UE shall determine the resource block assignment in frequency domain using the resource allocation field in the detected PDCCH DCI except for a PUSCH transmission scheduled by a RAR UL grant, in which case the frequency domain resource allocation is determined according to Subclause 8.3 of [6, 38.213]. Two uplink resource allocation schemes type 0 and type 1 are supported. Uplink resource allocation scheme type 0 is supported for PUSCH only when transform precoding is disabled. Uplink resource allocation scheme type 1 is supported for PUSCH for both cases when transform precoding is enabled or disabled.

If the scheduling DCI is configured to indicate the uplink resource allocation type as part of the *Frequency domain resource* assignment field by setting a higher layer parameter *resourceAllocation* in *pusch-Config* to 'dynamicSwitch', the UE shall use uplink resource allocation type 0 or type 1 as defined by this DCI field. Otherwise the UE shall use the uplink frequency resource allocation type as defined by the higher layer parameter *resourceAllocation*.

The UE shall assume that when the scheduling PDCCH is received with DCI format 0_0, then uplink resource allocation type 1 is used.

If a bandwidth part indicator field is not configured in the scheduling DCI or the UE does not support active bandwidth part change via DCI, the RB indexing for uplink type 0 and type 1 resource allocation is determined within the UE's active bandwidth part. If a bandwidth part indicator field is configured in the scheduling DCI and the UE supports active bandwidh part change via DCI, the RB indexing for uplink type 0 and type 1 resource allocation is determined within the UE's bandwidth part indicated by bandwidth part indicator field value in the DCI. The UE shall upon detection of PDCCH intended for the UE determine first the uplink bandwidth part and then the resource allocation within the bandwidth part. RB numbering starts from the lowest RB in the determined uplink bandwidth part.

6.1.2.2.1 Uplink resource allocation type 0

In uplink resource allocation of type 0, the resource block assignment information includes a bitmap indicating the Resource Block Groups (RBGs) that are allocated to the scheduled UE where a RBG is a set of consecutive virtual resource blocks defined by higher layer parameter *rbg-Size* configured in *pusch-Config* and the size of the bandwidth part as defined in Table 6.1.2.2.1-1.

Table 6.1.2.2.1-1: Nominal RBG size *P*

Bandwidth Part Size	Configuration 1	Configuration 2
1 – 36	2	4
37 – 72	4	8
73 – 144	8	16
145 – 275	16	16

The total number of RBGs (N_{RBG}) for a uplink bandwidth part i of size $N_{\mathrm{BWP},i}^{size}$ PRBs is given by

$$N_{RBG} = \left\lceil \left(N_{BWP,i}^{size} + \left(N_{BWP,i}^{start} \bmod P \right) \right) / P \right\rceil$$ where

- the size of the first RBG is $RBG_0^{size} = P - N_{BWP,i}^{start} \bmod P$,
- the size of the last RBG is $RBG_{last}^{size} = \left(N_{BWP,i}^{start} + N_{BWP,i}^{size} \right) \bmod P$ if $\left(N_{BWP,i}^{start} + N_{BWP,i}^{size} \right) \bmod P > 0$ and P otherwise.
- the size of all other RBG is P.

The bitmap is of size N_{RBG} bits with one bitmap bit per RBG such that each RBG is addressable. The RBGs shall be indexed in the order of increasing frequency of the bandwidth part and starting at the lowest frequency. The order of RBG bitmap is such that RBG 0 to RBG $N_{\mathrm{RBG}} - 1$ are mapped from MSB to LSB of the bitmap. The RBG is allocated to the UE if the corresponding bit value in the bitmap is 1, the RBG is not allocated to the UE otherwise.

In frequency range 1, only 'almost contiguous allocation' defined in [8, TS 38.101-1] is allowed as non-contiguous allocation per component carrier for UL RB allocation for CP-OFDM.

In frequency range 2, non-contiguous allocation per component carrier for UL RB allocation for CP-OFDM is not supported.

6.1.2.2.2 Uplink resource allocation type 1

In uplink resource allocation of type 1, the resource block assignment information indicates to a scheduled UE a set of contiguously allocated non-interleaved virtual resource blocks within the active bandwidth part of size N_{BWP}^{size} PRBs except for the case when DCI format 0_0 is decoded in any common search space in which case the size of the initial UL bandwidth part $N_{\mathrm{BWP},0}^{size}$ shall be used.

An uplink type 1 resource allocation field consists of a resource indication value (RIV) corresponding to a starting virtual resource block (RB_{start}) and a length in terms of contiguously allocated resource blocks L_{RBs} . The resource indication value is defined by

if $(L_{RBs}-1) \le \lfloor N_{BWP}^{size}/2 \rfloor$ then

$$RIV = N_{BWP}^{size}(L_{RBs}-1)+RB_{start}$$

else

$$RIV = N_{BWP}^{size}(N_{BWP}^{size}-L_{RBs}+1)+(N_{BWP}^{size}-1-RB_{start})$$

where $L_{RBs} \ge 1$ and shall not exceed $N_{BWP}^{size}-RB_{start}$.

When the DCI size for DCI format 0_0 in USS is derived from the initial UL BWP with size $N_{\mathrm{BWP}}^{initial}$ but applied to another active BWP with size of $N_{\mathrm{BWP}}^{active}$, an uplink type 1 resource block assignment field consists of a resource indication value (RIV) corresponding to a starting resource block $RB_{start} = 0, K, 2\cdot K, \ldots, (N_{\mathrm{BWP}}^{initial}-1)\cdot K$ and a length in terms of virtually contiguously allocated resource blocks $L_{RBs} = K, 2\cdot K, \ldots, N_{\mathrm{BWP}}^{initial}\cdot K$.

The resource indication value is defined by

if $(L'_{RBs}-1) \le \lfloor N_{BWP}^{initial}/2 \rfloor$ then

$$RIV = N_{BWP}^{initial}(L'_{RBs}-1)+RB'_{start}$$

else

$$RIV = N_{BWP}^{initial}(N_{BWP}^{initial}-L'_{RBs}+1)+(N_{BWP}^{initial}-1-RB'_{start})$$

where $L'_{RBs} = L_{RBs}/K$, $RB'_{start} = RB_{start}/K$ and where L'_{RBs} shall not exceed $N_{BWP}^{initial}-RB'_{start}$.

If $N_{BWP}^{active} > N_{BWP}^{initial}$, K is the maximum value from set {1, 2, 4, 8} which satisfies $K \le \lfloor N_{BWP}^{active}/N_{BWP}^{initial} \rfloor$; otherwise $K = 1$.

108. The Samsung 5G Accused Products further practice the step of deriving, by the UE, a resource allocation scheduled by a network and carried by the PDCCH for the PDSCH or the PUSCH for the first numerology within the first bandwidth portion based on the PDCCH, the first frequency location and the first bandwidth. For example, this functionality is described in the 5G Standard, including but not limited to in 3GPP TS 38.331 section 6, 3GPP TS 38.213 section 12, 3GPP TS 38.211 section 4, and 3GPP TS 38.214 sections 5 and 6.

3GPP TS 38.331

6.3.2 Radio resource control information elements

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– *BWP*

The IE *BWP* is used to configure generic parameters of a bandwidth part as defined in TS 38.211 [16], clause 4.5, and TS 38.213 [13], clause 12.

For each serving cell the network configures at least an initial downlink bandwidth part and one (if the serving cell is configured with an uplink) or two (if using supplementary uplink (SUL)) initial uplink bandwidth parts. Furthermore, the network may configure additional uplink and downlink bandwidth parts for a serving cell.

The uplink and downlink bandwidth part configurations are divided into common and dedicated parameters.

BWP **information element**

```
-- ASN1START
-- TAG-BWP-START

BWP ::=                             SEQUENCE {
    locationAndBandwidth                INTEGER (0..37949),
    subcarrierSpacing                   SubcarrierSpacing,
    cyclicPrefix                        ENUMERATED { extended }                              OPTIONAL    -- Need R
}

-- TAG-BWP-STOP
-- ASN1STOP
```

BWP **field descriptions**
cyclicPrefix Indicates whether to use the extended cyclic prefix for this bandwidth part. If not set, the UE uses the normal cyclic prefix. Normal CP is supported for all subcarrier spacings and slot formats. Extended CP is supported only for 60 kHz subcarrier spacing. (see TS 38.211 [16], clause 4.2)
locationAndBandwidth Frequency domain location and bandwidth of this bandwidth part. The value of the field shall be interpreted as resource indicator value (RIV) as defined TS 38.214 [19] with assumptions as described in TS 38.213 [13], clause 12, i.e. setting N_{BWP}^{size}=275. The first PRB is a PRB determined by *subcarrierSpacing* of this BWP and *offsetToCarrier* (configured in *SCS-SpecificCarrier* contained within *FrequencyInfoDL* / *FrequencyInfoUL* / *FrequencyInfoUL-SIB* / *FrequencyInfoDL-SIB* within *ServingCellConfigCommon* / *ServingCellConfigCommonSIB*) corresponding to this subcarrier spacing. In case of TDD, a BWP-pair (UL BWP and DL BWP with the same *bwp-Id*) must have the same center frequency (see TS 38.213 [13], clause 12)
subcarrierSpacing Subcarrier spacing to be used in this BWP for all channels and reference signals unless explicitly configured elsewhere. Corresponds to subcarrier spacing according to TS 38.211 [16], table 4.2-1. The value *kHz15* corresponds to µ=0, value *kHz30* corresponds to µ=1, and so on. Only the values 15 kHz, 30 kHz, or 60 kHz (FR1), and 60 kHz or 120 kHz (FR2) are applicable. For the initial DL BWP this field has the same value as the field *subCarrierSpacingCommon* in *MIB* of the same serving cell.

. . .

– *SCS-SpecificCarrier*

The IE *SCS-SpecificCarrier* provides parameters determining the location and width of the actual carrier or the carrier bandwidth. It is defined specifically for a numerology (subcarrier spacing (SCS)) and in relation (frequency offset) to Point A.

SCS-SpecificCarrier **information element**

```
-- ASN1START
-- TAG-SCS-SPECIFICCARRIER-START

SCS-SpecificCarrier ::=             SEQUENCE {
    offsetToCarrier                     INTEGER (0..2199),
    subcarrierSpacing                   SubcarrierSpacing,
    carrierBandwidth                    INTEGER (1..maxNrofPhysicalResourceBlocks),
    ...,
    [[
    txDirectCurrentLocation         INTEGER (0..4095)                        OPTIONAL                -- Need S
    ]]
}

-- TAG-SCS-SPECIFICCARRIER-STOP
-- ASN1STOP
```

SCS-SpecificCarrier **field descriptions**
carrierBandwidth Width of this carrier in number of PRBs (using the *subcarrierSpacing* defined for this carrier) (see TS 38.211 [16], clause 4.4.2).
offsetToCarrier Offset in frequency domain between Point A (lowest subcarrier of common RB 0) and the lowest usable subcarrier on this carrier in number of PRBs (using the subcarrierSpacing defined for this carrier). The maximum value corresponds to 275*8-1. See TS 38.211 [16], clause 4.4.2.
txDirectCurrentLocation Indicates the downlink Tx Direct Current location for the carrier. A value in the range 0..3299 indicates the subcarrier index within the carrier. The values in the value range 3301..4095 are reserved and ignored by the UE. If this field is absent for downlink within *ServingCellConfigCommon* and *ServingCellConfigCommonSIB*, the UE assumes the default value of 3300 (i.e. "Outside the carrier"). (see TS 38.211 [16], clause 4.4.2). Network does not configure this field via *ServingCellConfig* or for uplink carriers.
subcarrierSpacing Subcarrier spacing of this carrier. It is used to convert the offsetToCarrier into an actual frequency. Only the values 15 kHz, 30 kHz or 60 kHz (FR1), and 60 kHz or 120 kHz (FR2) are applicable.

3GPP TS 38.213

12 Bandwidth part operation

. . .

For each DL BWP or UL BWP in a set of DL BWPs or UL BWPs, respectively, the UE is provided the following parameters for the serving cell as defined in [4, TS 38.211] or [6, TS 38.214]:

- a SCS by *subcarrierSpacing*
- a cyclic prefix by *cyclicPrefix*
- a common RB $N_{\mathrm{BWP}}^{\mathrm{start}} = O_{\mathrm{carrier}} + RB_{\mathrm{start}}$ and a number of contiguous RBs $N_{\mathrm{BWP}}^{\mathrm{size}} = L_{\mathrm{RB}}$ provided by *locationAndBandwidth* that indicates an offset RB_{start} and a length L_{RB} as RIV according to [6, TS 38.214], setting $N_{\mathrm{BWP}}^{\mathrm{size}} = 275$, and a value O_{carrier} provided by *offsetToCarrier* for the *subcarrierSpacing*
- an index in the set of DL BWPs or UL BWPs by respective *BWP-Id*
- a set of BWP-common and a set of BWP-dedicated parameters by *BWP-DownlinkCommon* and *BWP-DownlinkDedicated* for the DL BWP, or *BWP-UplinkCommon* and *BWP-UplinkDedicated* for the UL BWP [12, TS 38.331]

. . .

A UE receives PDCCH and PDSCH in a DL BWP according to a configured SCS and CP length for the DL BWP. A UE transmits PUCCH and PUSCH in an UL BWP according to a configured SCS and CP length for the UL BWP.

3GPP TS 38.211

4.4.5 Bandwidth part

A bandwidth part is a subset of contiguous common resource blocks defined in subclause 4.4.4.3 for a given numerology μ_i in bandwidth part i on a given carrier. The starting position $N_{\mathrm{BWP},i}^{\mathrm{start},\mu}$ and the number of resource blocks $N_{\mathrm{BWP},i}^{\mathrm{size},\mu}$ in a bandwidth part shall fulfil $N_{\mathrm{grid},x}^{\mathrm{start},\mu} \le N_{\mathrm{BWP},i}^{\mathrm{start},\mu} < N_{\mathrm{grid},x}^{\mathrm{start},\mu} + N_{\mathrm{grid},x}^{\mathrm{size},\mu}$ and $N_{\mathrm{grid},x}^{\mathrm{start},\mu} < N_{\mathrm{BWP},i}^{\mathrm{start},\mu} + N_{\mathrm{BWP},i}^{\mathrm{size},\mu} \le N_{\mathrm{grid},x}^{\mathrm{start},\mu} + N_{\mathrm{grid},x}^{\mathrm{size},\mu}$, respectively. Configuration of a bandwidth part is described in clause 12 of [5, TS 38.213].

A UE can be configured with up to four bandwidth parts in the downlink with a single downlink bandwidth part being active at a given time. The UE is not expected to receive PDSCH, PDCCH, or CSI-RS (except for RRM) outside an active bandwidth part.

3GPP TS 38.214

5.1.2.2 Resource allocation in frequency domain

Two downlink resource allocation schemes, type 0 and type 1, are supported. The UE shall assume that when the scheduling grant is received with DCI format 1_0, then downlink resource allocation type 1 is used.

If the scheduling DCI is configured to indicate the downlink resource allocation type as part of the *Frequency domain resource assignment* field by setting a higher layer parameter *resourceAllocation* in *pdsch-Config* to 'dynamicswitch', the UE shall use downlink resource allocation type 0 or type 1 as defined by this DCI field. Otherwise the UE shall use the downlink frequency resource allocation type as defined by the higher layer parameter *resourceAllocation*.

If a bandwidth part indicator field is not configured in the scheduling DCI or the UE does not support active BWP change via DCI, the RB indexing for downlink type 0 and type 1 resource allocation is determined within the UE's active bandwidth part. If a bandwidth part indicator field is configured in the scheduling DCI and the UE supports active BWP change via DCI, the RB indexing for downlink type 0 and type 1 resource allocation is determined within the UE's bandwidth part indicated by bandwidth part indicator field value in the DCI. The UE shall upon detection of PDCCH intended for the UE determine first the downlink bandwidth part and then the resource allocation within the bandwidth part.

For a PDSCH scheduled with a DCI format 1_0 in any type of PDCCH common search space, regardless of which bandwidth part is the active bandwidth part, RB numbering starts from the lowest RB of the CORESET in which the DCI was received; otherwise RB numbering starts from the lowest RB in the determined downlink bandwidth part.

5.1.2.2.1 Downlink resource allocation type 0

In downlink resource allocation of type 0, the resource block assignment information includes a bitmap indicating the Resource Block Groups (RBGs) that are allocated to the scheduled UE where a RBG is a set of consecutive virtual resource blocks defined by higher layer parameter *rbg-Size* configured by *PDSCH-Config* and the size of the bandwidth part as defined in Table 5.1.2.2.1-1.

Table 5.1.2.2.1-1: Nominal RBG size *P*

Bandwidth Part Size	Configuration 1	Configuration 2
1 – 36	2	4
37 – 72	4	8
73 – 144	8	16
145 – 275	16	16

The total number of RBGs (N_{RBG}) for a downlink bandwidth part i of size $N_{\mathrm{BWP},i}^{size}$ PRBs is given by

$$N_{RBG} = \left\lceil \left(N_{BWP,i}^{size} + \left(N_{BWP,i}^{start} \bmod P \right) \right) / P \right\rceil,$$ where

- the size of the first RBG is $RBG_0^{size} = P - N_{BWP,i}^{start} \bmod P$,
- the size of last RBG is $RBG_{last}^{size} = \left(N_{BWP,i}^{start} + N_{BWP,i}^{size} \right) \bmod P$ if $\left(N_{BWP,i}^{start} + N_{BWP,i}^{size} \right) \bmod P > 0$ and P otherwise,
- the size of all other RBGs is P.

The bitmap is of size N_{RBG} bits with one bitmap bit per RBG such that each RBG is addressable. The RBGs shall be indexed in the order of increasing frequency and starting at the lowest frequency of the bandwidth part. The order of RBG bitmap is such that RBG 0 to RBG $N_{\mathrm{RBG}} - 1$ are mapped from MSB to LSB. The RBG is allocated to the UE if the corresponding bit value in the bitmap is 1, the RBG is not allocated to the UE otherwise.

5.1.2.2.2 Downlink resource allocation type 1

In downlink resource allocation of type 1, the resource block assignment information indicates to a scheduled UE a set of contiguously allocated non-interleaved or interleaved virtual resource blocks within the active bandwidth part of size N_{BWP}^{size} PRBs except for the case when DCI format 1_0 is decoded in any common search space in which case the size of CORESET 0 shall be used if CORESET 0 is configured for the cell and the size of initial DL bandwidth part shall be used if CORESET 0 is not configured for the cell.

A downlink type 1 resource allocation field consists of a resource indication value (*RIV*) corresponding to a starting virtual resource block (RB_{start}) and a length in terms of contiguously allocated resource blocks L_{RBs} . The resource indication value is defined by

if $(L_{RBs} - 1) \le \lfloor N_{BWP}^{size} / 2 \rfloor$ then

$$RIV = N_{BWP}^{size}(L_{RBs} - 1) + RB_{start}$$

else

$$RIV = N_{BWP}^{size}(N_{BWP}^{size} - L_{RBs} + 1) + (N_{BWP}^{size} - 1 - RB_{start})$$

where $L_{RBs} \ge 1$ and shall not exceed $N_{BWP}^{size} - RB_{start}$.

When the DCI size for DCI format 1_0 in USS is derived from the size of DCI format 1_0 in CSS but applied to an active BWP with size of $N_{\mathrm{BWP}}^{active}$, a downlink type 1 resource block assignment field consists of a resource indication value (*RIV*) corresponding to a starting resource block $RB_{start} = 0, K, 2 \cdot K, \ldots, (N_{\mathrm{BWP}}^{initial} - 1) \cdot K$ and a length in terms of virtually contiguously allocated resource blocks $L_{RBs} = K, 2 \cdot K, \ldots, N_{\mathrm{BWP}}^{initial} \cdot K$, where $N_{\mathrm{BWP}}^{initial}$ is given by

- the size of CORESET 0 if CORESET 0 is configured for the cell;
- the size of initial DL bandwidth part if CORESET 0 is not configured for the cell.

The resource indication value is defined by:

if $(L'_{RBs} - 1) \le \lfloor N_{BWP}^{initial} / 2 \rfloor$ then

$$RIV = N_{BWP}^{initial}(L'_{RBs} - 1) + RB'_{start}$$

else

$$RIV = N_{BWP}^{initial}(N_{BWP}^{initial} - L'_{RBs} + 1) + (N_{BWP}^{initial} - 1 - RB'_{start})$$

where $L'_{RBs} = L_{RBs} / K$, $RB'_{start} = RB_{start} / K$ and where L'_{RBs} shall not exceed $N_{BWP}^{initial} - RB'_{start}$.

If $N_{BWP}^{active} > N_{BWP}^{initial}$, K is the maximum value from set {1, 2, 4, 8} which satisfies $K \le \lfloor N_{BWP}^{active} / N_{BWP}^{initial} \rfloor$; otherwise $K = 1$.

. . .

6.1.2.2 Resource allocation in frequency domain

The UE shall determine the resource block assignment in frequency domain using the resource allocation field in the detected PDCCH DCI except for a PUSCH transmission scheduled by a RAR UL grant, in which case the frequency domain resource allocation is determined according to Subclause 8.3 of [6, 38.213]. Two uplink resource allocation schemes type 0 and type 1 are supported. Uplink resource allocation scheme type 0 is supported for PUSCH only when transform precoding is disabled. Uplink resource allocation scheme type 1 is supported for PUSCH for both cases when transform precoding is enabled or disabled.

If the scheduling DCI is configured to indicate the uplink resource allocation type as part of the *Frequency domain resource* assignment field by setting a higher layer parameter r*esourceAllocation* in *pusch-Config* to 'dynamicSwitch', the UE shall use uplink resource allocation type 0 or type 1 as defined by this DCI field. Otherwise the UE shall use the uplink frequency resource allocation type as defined by the higher layer parameter *resourceAllocation*.

The UE shall assume that when the scheduling PDCCH is received with DCI format 0_0, then uplink resource allocation type 1 is used.

If a bandwidth part indicator field is not configured in the scheduling DCI or the UE does not support active bandwidth part change via DCI, the RB indexing for uplink type 0 and type 1 resource allocation is determined within the UE's active bandwidth part. If a bandwidth part indicator field is configured in the scheduling DCI and the UE supports active bandwidh part change via DCI, the RB indexing for uplink type 0 and type 1 resource allocation is determined within the UE's bandwidth part indicated by bandwidth part indicator field value in the DCI. The UE shall upon detection of PDCCH intended for the UE determine first the uplink bandwidth part and then the resource allocation within the bandwidth part. RB numbering starts from the lowest RB in the determined uplink bandwidth part.

6.1.2.2.1 Uplink resource allocation type 0

In uplink resource allocation of type 0, the resource block assignment information includes a bitmap indicating the Resource Block Groups (RBGs) that are allocated to the scheduled UE where a RBG is a set of consecutive virtual resource blocks defined by higher layer parameter *rbg-Size* configured in *pusch-Config* and the size of the bandwidth part as defined in Table 6.1.2.2.1-1.

Table 6.1.2.2.1-1: Nominal RBG size *P*

Bandwidth Part Size	Configuration 1	Configuration 2
1 – 36	2	4
37 – 72	4	8
73 – 144	8	16
145 – 275	16	16

The total number of RBGs (N_{RBG}) for a uplink bandwidth part *i* of size $N_{\mathrm{BWP},i}^{size}$ PRBs is given by

$$N_{RBG} = \left\lceil \left(N_{BWP,i}^{size} + \left(N_{BWP,i}^{start} \bmod P \right) \right) / P \right\rceil$$ where

- the size of the first RBG is $RBG_0^{size} = P - N_{BWP,i}^{start} \bmod P$,
- the size of the last RBG is $RBG_{last}^{size} = \left(N_{BWP,i}^{start} + N_{BWP,i}^{size} \right) \bmod P$ if $\left(N_{BWP,i}^{start} + N_{BWP,i}^{size} \right) \bmod P > 0$ and P otherwise.
- the size of all other RBG is *P*.

The bitmap is of size N_{RBG} bits with one bitmap bit per RBG such that each RBG is addressable. The RBGs shall be indexed in the order of increasing frequency of the bandwidth part and starting at the lowest frequency. The order of RBG bitmap is such that RBG 0 to RBG $N_{\mathrm{RBG}} - 1$ are mapped from MSB to LSB of the bitmap. The RBG is allocated to the UE if the corresponding bit value in the bitmap is 1, the RBG is not allocated to the UE otherwise.

In frequency range 1, only 'almost contiguous allocation' defined in [8, TS 38.101-1] is allowed as non-contiguous allocation per component carrier for UL RB allocation for CP-OFDM.

In frequency range 2, non-contiguous allocation per component carrier for UL RB allocation for CP-OFDM is not supported.

6.1.2.2.2 Uplink resource allocation type 1

In uplink resource allocation of type 1, the resource block assignment information indicates to a scheduled UE a set of contiguously allocated non-interleaved virtual resource blocks within the active bandwidth part of size N_{BWP}^{size} PRBs except for the case when DCI format 0_0 is decoded in any common search space in which case the size of the initial UL bandwidth part $N_{\mathrm{BWP},0}^{size}$ shall be used.

An uplink type 1 resource allocation field consists of a resource indication value (*RIV*) corresponding to a starting virtual resource block (RB_{start}) and a length in terms of contiguously allocated resource blocks L_{RBs} . The resource indication value is defined by

if $(L_{RBs} - 1) \leq \lfloor N_{BWP}^{size} / 2 \rfloor$ then

$$RIV = N_{BWP}^{size}(L_{RBs} - 1) + RB_{start}$$

else

$$RIV = N_{BWP}^{size}(N_{BWP}^{size} - L_{RBs} + 1) + (N_{BWP}^{size} - 1 - RB_{start})$$

where $L_{RBs} \geq 1$ and shall not exceed $N_{BWP}^{size} - RB_{start}$.

When the DCI size for DCI format 0_0 in USS is derived from the initial UL BWP with size $N_{\mathrm{BWP}}^{initial}$ but applied to another active BWP with size of $N_{\mathrm{BWP}}^{active}$, an uplink type 1 resource block assignment field consists of a resource indication value (*RIV*) corresponding to a starting resource block $RB_{start} = 0, K, 2 \cdot K, \ldots, (N_{\mathrm{BWP}}^{initial} - 1) \cdot K$ and a length in terms of virtually contiguously allocated resource blocks $L_{RBs} = K, 2 \cdot K, \ldots, N_{\mathrm{BWP}}^{initial} \cdot K$.

The resource indication value is defined by

if $(L'_{RBs} - 1) \leq \lfloor N_{BWP}^{initial} / 2 \rfloor$ then

$$RIV = N_{BWP}^{initial}(L'_{RBs} - 1) + RB'_{start}$$

else

$$RIV = N_{BWP}^{initial}(N_{BWP}^{initial} - L'_{RBs} + 1) + (N_{BWP}^{initial} - 1 - RB'_{start})$$

where $L'_{RBs} = L_{RBs} / K$, $RB'_{start} = RB_{start} / K$ and where L'_{RBs} shall not exceed $N_{BWP}^{initial} - RB'_{start}$.

If $N_{BWP}^{active} > N_{BWP}^{initial}$, K is the maximum value from set {1, 2, 4, 8} which satisfies $K \leq \lfloor N_{BWP}^{active} / N_{BWP}^{initial} \rfloor$; otherwise $K = 1$.

109. The Samsung 5G Accused Products further practice the foregoing step wherein the resource allocation within the first bandwidth portion is done via a bit map indicating which resource unit within the first bandwidth portion is allocated for the UE. For example, this functionality is described in the 5G Standard, including but not limited to in 3GPP TS 38.214 sections 5 and 6.

5.1.2.2 Resource allocation in frequency domain

Two downlink resource allocation schemes, type 0 and type 1, are supported. The UE shall assume that when the scheduling grant is received with DCI format 1_0, then downlink resource allocation type 1 is used.

If the scheduling DCI is configured to indicate the downlink resource allocation type as part of the *Frequency domain resource assignment* field by setting a higher layer parameter *resourceAllocation* in *pdsch-Config* to 'dynamicswitch', the UE shall use downlink resource allocation type 0 or type 1 as defined by this DCI field. Otherwise the UE shall use the downlink frequency resource allocation type as defined by the higher layer parameter *resourceAllocation*.

If a bandwidth part indicator field is not configured in the scheduling DCI or the UE does not support active BWP change via DCI, the RB indexing for downlink type 0 and type 1 resource allocation is determined within the UE's active bandwidth part. If a bandwidth part indicator field is configured in the scheduling DCI and the UE supports active BWP change via DCI, the RB indexing for downlink type 0 and type 1 resource allocation is determined within the UE's bandwidth part indicated by bandwidth part indicator field value in the DCI. The UE shall upon detection of PDCCH intended for the UE determine first the downlink bandwidth part and then the resource allocation within the bandwidth part.

For a PDSCH scheduled with a DCI format 1_0 in any type of PDCCH common search space, regardless of which bandwidth part is the active bandwidth part, RB numbering starts from the lowest RB of the CORESET in which the DCI was received; otherwise RB numbering starts from the lowest RB in the determined downlink bandwidth part.

5.1.2.2.1 Downlink resource allocation type 0

In downlink resource allocation of type 0, the resource block assignment information includes a bitmap indicating the Resource Block Groups (RBGs) that are allocated to the scheduled UE where a RBG is a set of consecutive virtual resource blocks defined by higher layer parameter *rbg-Size* configured by *PDSCH-Config* and the size of the bandwidth part as defined in Table 5.1.2.2.1-1.

Table 5.1.2.2.1-1: Nominal RBG size *P*

Bandwidth Part Size	Configuration 1	Configuration 2
1 – 36	2	4
37 – 72	4	8
73 – 144	8	16
145 – 275	16	16

The total number of RBGs (N_{RBG}) for a downlink bandwidth part i of size $N_{\mathrm{BWP},i}^{size}$ PRBs is given by

$$N_{RBG} = \left\lceil \left(N_{BWP,i}^{size} + \left(N_{BWP,i}^{start} \bmod P \right) \right) / P \right\rceil, \text{ where}$$

- the size of the first RBG is $RBG_0^{size} = P - N_{BWP,i}^{start} \bmod P$,
- the size of last RBG is $RBG_{last}^{size} = \left(N_{BWP,i}^{start} + N_{BWP,i}^{size} \right) \bmod P$ if $\left(N_{BWP,i}^{start} + N_{BWP,i}^{size} \right) \bmod P > 0$ and P otherwise,
- the size of all other RBGs is P.

The bitmap is of size N_{RBG} bits with one bitmap bit per RBG such that each RBG is addressable. The RBGs shall be indexed in the order of increasing frequency and starting at the lowest frequency of the bandwidth part. The order of RBG bitmap is such that RBG 0 to RBG $N_{\mathrm{RBG}} - 1$ are mapped from MSB to LSB. The RBG is allocated to the UE if the corresponding bit value in the bitmap is 1, the RBG is not allocated to the UE otherwise.

5.1.2.2.2 Downlink resource allocation type 1

In downlink resource allocation of type 1, the resource block assignment information indicates to a scheduled UE a set of contiguously allocated non-interleaved or interleaved virtual resource blocks within the active bandwidth part of size N_{BWP}^{size} PRBs except for the case when DCI format 1_0 is decoded in any common search space in which case the size of CORESET 0 shall be used if CORESET 0 is configured for the cell and the size of initial DL bandwidth part shall be used if CORESET 0 is not configured for the cell.

A downlink type 1 resource allocation field consists of a resource indication value (*RIV*) corresponding to a starting virtual resource block (RB_{start}) and a length in terms of contiguously allocated resource blocks L_{RBs} . The resource indication value is defined by

if $(L_{RBs}-1)\leq\lfloor N_{BWP}^{size}/2\rfloor$ then

$$RIV=N_{BWP}^{size}(L_{RBs}-1)+RB_{start}$$

else

$$RIV=N_{BWP}^{size}(N_{BWP}^{size}-L_{RBs}+1)+(N_{BWP}^{size}-1-RB_{start})$$

where $L_{RBs}\geq 1$ and shall not exceed $N_{BWP}^{size}-RB_{start}$.

When the DCI size for DCI format 1_0 in USS is derived from the size of DCI format 1_0 in CSS but applied to an active BWP with size of N_{BWP}^{active} , a downlink type 1 resource block assignment field consists of a resource indication value (*RIV*) corresponding to a starting resource block $RB_{start}=0,K,2\cdot K,\ldots,(N_{\text{BWP}}^{initial}-1)\cdot K$ and a length in terms of virtually contiguously allocated resource blocks $L_{RBs}=K,2\cdot K,\ldots,N_{\text{BWP}}^{initial}\cdot K$, where $N_{\text{BWP}}^{initial}$ is given by

- the size of CORESET 0 if CORESET 0 is configured for the cell;
- the size of initial DL bandwidth part if CORESET 0 is not configured for the cell.

The resource indication value is defined by:

if $(L'_{RBs}-1)\leq\lfloor N_{BWP}^{initial}/2\rfloor$ then

$$RIV=N_{BWP}^{initial}(L'_{RBs}-1)+RB'_{start}$$

else

$$RIV=N_{BWP}^{initial}(N_{BWP}^{initial}-L'_{RBs}+1)+(N_{BWP}^{initial}-1-RB'_{start})$$

where $L'_{RBs}=L_{RBs}/K$, $RB'_{start}=RB_{start}/K$ and where L'_{RBs} shall not exceed $N_{BWP}^{initial}-RB'_{start}$.

If $N_{BWP}^{active}>N_{BWP}^{initial}$, K is the maximum value from set {1, 2, 4, 8} which satisfies $K\leq\lfloor N_{BWP}^{active}/N_{BWP}^{initial}\rfloor$; otherwise $K=1$.

. . .

6.1.2.2 Resource allocation in frequency domain

The UE shall determine the resource block assignment in frequency domain using the resource allocation field in the detected PDCCH DCI except for a PUSCH transmission scheduled by a RAR UL grant, in which case the frequency domain resource allocation is determined according to Subclause 8.3 of [6, 38.213]. Two uplink resource allocation schemes type 0 and type 1 are supported. Uplink resource allocation scheme type 0 is supported for PUSCH only when transform precoding is disabled. Uplink resource allocation scheme type 1 is supported for PUSCH for both cases when transform precoding is enabled or disabled.

If the scheduling DCI is configured to indicate the uplink resource allocation type as part of the *Frequency domain resource* assignment field by setting a higher layer parameter r*esourceAllocation* in *pusch-Config* to 'dynamicSwitch', the UE shall use uplink resource allocation type 0 or type 1 as defined by this DCI field. Otherwise the UE shall use the uplink frequency resource allocation type as defined by the higher layer parameter *resourceAllocation*.

The UE shall assume that when the scheduling PDCCH is received with DCI format 0_0, then uplink resource allocation type 1 is used.

If a bandwidth part indicator field is not configured in the scheduling DCI or the UE does not support active bandwidth part change via DCI, the RB indexing for uplink type 0 and type 1 resource allocation is determined within the UE's active bandwidth part. If a bandwidth part indicator field is configured in the scheduling DCI and the UE supports active bandwidh part change via DCI, the RB indexing for uplink type 0 and type 1 resource allocation is determined within the UE's bandwidth part indicated by bandwidth part indicator field value in the DCI. The UE shall upon detection of PDCCH intended for the UE determine first the uplink bandwidth part and then the resource allocation within the bandwidth part. RB numbering starts from the lowest RB in the determined uplink bandwidth part.

6.1.2.2.1 Uplink resource allocation type 0

In uplink resource allocation of type 0, the resource block assignment information includes a bitmap indicating the Resource Block Groups (RBGs) that are allocated to the scheduled UE where a RBG is a set of consecutive virtual resource blocks defined by higher layer parameter *rbg-Size* configured in *pusch-Config* and the size of the bandwidth part as defined in Table 6.1.2.2.1-1.

Table 6.1.2.2.1-1: Nominal RBG size *P*

Bandwidth Part Size	Configuration 1	Configuration 2
1 – 36	2	4
37 – 72	4	8
73 – 144	8	16
145 – 275	16	16

The total number of RBGs (N_{RBG}) for a uplink bandwidth part *i* of size $N^{size}_{\mathrm{BWP},i}$ PRBs is given by

$$N_{RBG} = \left\lceil \left(N^{size}_{BWP,i} + \left(N^{start}_{BWP,i} \bmod P \right) \right) / P \right\rceil$$ where

- the size of the first RBG is $RBG^{size}_0 = P - N^{start}_{BWP,i} \bmod P$,
- the size of the last RBG is $RBG^{size}_{last} = \left(N^{start}_{BWP,i} + N^{size}_{BWP,i} \right) \bmod P$ if $\left(N^{start}_{BWP,i} + N^{size}_{BWP,i} \right) \bmod P > 0$ and P otherwise.
- the size of all other RBG is *P*.

The bitmap is of size N_{RBG} bits with one bitmap bit per RBG such that each RBG is addressable. The RBGs shall be indexed in the order of increasing frequency of the bandwidth part and starting at the lowest frequency. The order of RBG bitmap is such that RBG 0 to RBG $N_{\mathrm{RBG}} - 1$ are mapped from MSB to LSB of the bitmap. The RBG is allocated to the UE if the corresponding bit value in the bitmap is 1, the RBG is not allocated to the UE otherwise.

In frequency range 1, only 'almost contiguous allocation' defined in [8, TS 38.101-1] is allowed as non-contiguous allocation per component carrier for UL RB allocation for CP-OFDM.

In frequency range 2, non-contiguous allocation per component carrier for UL RB allocation for CP-OFDM is not supported.

6.1.2.2.2 Uplink resource allocation type 1

In uplink resource allocation of type 1, the resource block assignment information indicates to a scheduled UE a set of contiguously allocated non-interleaved virtual resource blocks within the active bandwidth part of size N_{BWP}^{size} PRBs except for the case when DCI format 0_0 is decoded in any common search space in which case the size of the initial UL bandwidth part $N_{\text{BWP},0}^{size}$ shall be used.

An uplink type 1 resource allocation field consists of a resource indication value (*RIV*) corresponding to a starting virtual resource block (RB_{start}) and a length in terms of contiguously allocated resource blocks L_{RBs} . The resource indication value is defined by

if $(L_{RBs}-1) \leq \lfloor N_{BWP}^{size}/2 \rfloor$ then

$$RIV = N_{BWP}^{size}(L_{RBs}-1) + RB_{start}$$

else

$$RIV = N_{BWP}^{size}(N_{BWP}^{size} - L_{RBs} + 1) + (N_{BWP}^{size} - 1 - RB_{start})$$

where $L_{RBs} \geq 1$ and shall not exceed $N_{BWP}^{size} - RB_{start}$.

When the DCI size for DCI format 0_0 in USS is derived from the initial UL BWP with size $N_{\text{BWP}}^{initial}$ but applied to another active BWP with size of N_{BWP}^{active} , an uplink type 1 resource block assignment field consists of a resource indication value (*RIV*) corresponding to a starting resource block $RB_{start} = 0, K, 2 \cdot K, \ldots, (N_{\text{BWP}}^{initial} - 1) \cdot K$ and a length in terms of virtually contiguously allocated resource blocks $L_{RBs} = K, 2 \cdot K, \ldots, N_{\text{BWP}}^{initial} \cdot K$.

The resource indication value is defined by

if $(L'_{RBs}-1) \leq \lfloor N_{BWP}^{initial}/2 \rfloor$ then

$$RIV = N_{BWP}^{initial}(L'_{RBs}-1) + RB'_{start}$$

else

$$RIV = N_{BWP}^{initial}(N_{BWP}^{initial} - L'_{RBs} + 1) + (N_{BWP}^{initial} - 1 - RB'_{start})$$

where $L'_{RBs} = L_{RBs}/K$, $RB'_{start} = RB_{start}/K$ and where L'_{RBs} shall not exceed $N_{BWP}^{initial} - RB'_{start}$.

If $N_{BWP}^{active} > N_{BWP}^{initial}$, K is the maximum value from set {1, 2, 4, 8} which satisfies $K \leq \lfloor N_{BWP}^{active} / N_{BWP}^{initial} \rfloor$; otherwise $K = 1$.

110. Accordingly, as illustrated above, the Samsung 5G Accused Products directly infringe one or more claims of the '759 Patent. Samsung makes, uses, sells, offers for sale, and/or imports, in this District and/or elsewhere in the United States, the Samsung 5G Accused Products and thus directly infringes the '759 Patent.

111. Samsung has also indirectly infringed and continues to indirectly infringe the '759 Patent, as provided in 35 U.S.C. § 271(b), including at least by inducing infringement by others, such as Samsung's customers and end-users, in this District and elsewhere in the United States,

to use the Samsung 5G Accused Products in manners that infringe the '759 Patent. For example, Samsung's customers and end-users directly infringe via their use of the Samsung 5G Accused Products to access and use 5G wireless technologies, infringing the '759 Patent. Samsung induces such direct infringement through its affirmative acts of making, using, selling, offering to sell, and/or importing the Samsung 5G Accused Products, as well as by advertising its 5G wireless technologies and providing instructions, documentation, and other information to its customers and end-users to encourage and teach them how to use the infringing 5G wireless technologies, including but not limited to by Samsung providing in-store and online technical support, marketing materials, product manuals, advertisements, and other product documentation. Samsung performs these affirmative acts with knowledge of the '759 Patent and with the intent, or willful blindness, that the induced acts directly infringe the '759 Patent.

112. Samsung has also indirectly infringed and continues to indirectly infringe the '759 Patent, as provided by 35 U.S.C. § 271(c), by contributing to direct infringement committed by others, such as Samsung's customers and end-users, in this District and elsewhere in the United States. Samsung's affirmative acts of selling and offering to sell the Samsung 5G Accused Products in this District and elsewhere in the United States, and causing the Samsung 5G Accused Products to be manufactured, used, sold, and offered for sale, contribute to Samsung's customers and end-users using the Samsung 5G Accused Products, such that the '759 Patent is directly infringed. The accused components in the Samsung 5G Accused Products are material to the inventions claimed in the '759 Patent, are not staple articles or commodities of commerce, have no substantial non-infringing uses, and are known by Samsung to be especially made or adapted for use in the infringement of the '759 Patent. Samsung performs these affirmative acts with knowledge of the '759 Patent and with the intent, or willful blindness, that they cause direct infringement of the '759 Patent.

113. Samsung has also infringed and continues to infringe the '759 Patent, as provided by 35 U.S.C. § 271(f)(1), by supplying or causing to be supplied in or from the United States all or a substantial portion of the components of the Samsung 5G Accused Products, uncombined in whole or in part, in such a manner as to actively induce their combination outside the United States in a manner that would infringe the '759 Patent if such combination occurred within the United States. Samsung has likewise infringed and continues to infringe the '759 Patent, as provided by 35 U.S.C. § 271(f)(2), by supplying or causing to be supplied in or from the United States components of the Samsung 5G Accused Products that are especially made or especially adapted for infringement of the '759 Patent. The accused components in the Samsung 5G Accused Products are material to the inventions claimed in the '759 Patent, are not staple articles or commodities of commerce, have no substantial non-infringing uses, and are known by Samsung to be especially made or adapted for use in the infringement of the '759 Patent. Samsung performs these affirmative acts with knowledge of the '759 Patent and with the intent, or willful blindness, that they cause direct infringement of the '759 Patent.

114. Samsung's infringement of the '759 Patent has damaged and will continue to damage the Plaintiffs.

115. Samsung has had knowledge of the '759 Patent, and its infringement thereof, at least since January 19, 2022, when Plaintiffs provided Samsung notice that it is infringing the '759 Patent. Samsung continues without license to make, use, sell, offer to sell, and/or import the Samsung 5G Accused Products, willfully continuing Samsung's infringement.

<u>COUNT V: INFRINGEMENT OF THE '585 PATENT</u>

116. Plaintiffs incorporate by reference the preceding paragraphs as though fully set forth herein.

117. .S. Patent No. 10,986,585 ("the '585 Patent") was duly and legally issued on April 20, 2021, for an invention titled, "Method And Apparatus For Triggering Power Headroom Report For Multiple Pathloss Reference In A Wireless Communication System."

118. Plaintiffs own all rights to the '585 Patent that are necessary to bring this action.

119. Samsung is not currently licensed to practice the '585 Patent.

120. Samsung infringes, contributes to the infringement of, and/or induces infringement of the '585 Patent by making, using, selling, offering for sale, and/or importing the Samsung 5G Accused Products in/into the United States.

121. For example and as shown below, the Samsung 5G Accused Products infringe at least claim 1 of the '585 Patent by virtue of their compatibility with and practice of the 5G Standard. For example, and to the extent the preamble is limiting, the Samsung 5G Accused Products practice a method for deriving a pathloss change. For example, this functionality is described in the 5G Standard, including but not limited to in 3GPP TS 38.321 section 5.

3GPP TS 38.321

5.4.6 Power Headroom Reporting

. . .

A Power Headroom Report (PHR) shall be triggered if any of the following events occur:

- *phr-ProhibitTimer* expires or has expired and the path loss has changed more than *phr-Tx-PowerFactorChange* dB for at least one RS used as pathloss reference for one activated Serving Cell of any MAC entity of which the active DL BWP is not dormant BWP since the last transmission of a PHR in this MAC entity when the MAC entity has UL resources for new transmission;

122. The Samsung 5G Accused Products further practice the step whereby a UE (User Equipment) derives a first pathloss value from a first pathloss reference of a serving cell. For example, this functionality is described in the 5G Standard, including but not limited to in 3GPP TS 38.213 section 7.

<u>3GPP TS 38.213</u>

7.1.1 UE behaviour

. . .

- $PL_{b,f,c}(q_d)$ is a downlink pathloss estimate in dB calculated by the UE using reference signal (RS) index q_d for the active DL BWP, as described in clause 12, of carrier f of serving cell c

123. The Samsung 5G Accused Products further practice the foregoing step wherein the first pathloss value is used for deriving a power headroom value included in a first power headroom report. For example, this functionality is described in the 5G Standard, including but not limited to in 3GPP TS 38.213 section 7.

<u>3GPP TS 38.213</u>

7.7.1 Type 1 PH report

If a UE determines that a Type 1 power headroom report for an activated serving cell is based on an actual PUSCH transmission then, for PUSCH transmission occasion i on active UL BWP b of carrier f of serving cell c, the UE computes the Type 1 power headroom report as

$$PH_{\text{type1},b,f,c}(i,j,q_d,l) = P_{\text{CMAX},f,c}(i) - \left\{P_{\text{O\_PUSCH},b,f,c}(j) + 10log_{10}\left(2^{\mu} \cdot M_{\text{RB},b,f,c}^{\text{PUSCH}}(i)\right) + \alpha_{b,f,c}(j) \cdot PL_{b,f,c}(q_d) + \Delta_{\text{TF},b,f,c}(i) + f_{b,f,c}(i,l)\right\} \text{ [dB]}$$

124. The Samsung 5G Accused Products further practice the step whereby the UE derives a second pathloss value from a second pathloss reference of the serving cell after deriving the first pathloss value, wherein the second pathloss reference is separate from the first pathloss reference. For example, this functionality is described in the 5G Standard, including but not limited to in 3GPP TS 38.213 section 7.

<u>3GPP TS 38.213</u>

7.1.1 UE behaviour

. . .

- $PL_{b,f,c}(q_d)$ is a downlink pathloss estimate in dB calculated by the UE using reference signal (RS) index q_d for the active DL BWP, as described in clause 12, of carrier f of serving cell c

125. The Samsung 5G Accused Products further practice the foregoing step wherein the second pathloss reference is used for power control for a first Physical Uplink Shared Channel

(PUSCH) transmission on the serving cell. For example, this functionality is described in the 5G Standard, including but not limited to in 3GPP TS 38.213 section 7.

3GPP TS 38.213

7.1.1 UE behaviour

If a UE transmits a PUSCH on active UL BWP b of carrier f of serving cell c using parameter set configuration with index j and PUSCH power control adjustment state with index l, the UE determines the PUSCH transmission power $P_{\mathrm{PUSCH},b,f,c}(i,j,q_d,l)$ in PUSCH transmission occasion i as

$$P_{\mathrm{PUSCH},b,f,c}(i,j,q_d,l)=\min\begin{Bmatrix}P_{\mathrm{CMAX},f,c}(i),\\ P_{\mathrm{O\_PUSCH},b,f,c}(j)+10\log_{10}(2^{\mu}\cdot M^{\mathrm{PUSCH}}_{\mathrm{RB},b,f,c}(i))+\alpha_{b,f,c}(j)\cdot PL_{b,f,c}(q_d)+\Delta_{\mathrm{TF},b,f,c}(i)+f_{b,f,c}(i,l)\end{Bmatrix}$$

[dBm]

. . .

- $PL_{b,f,c}(q_d)$ is a downlink pathloss estimate in dB calculated by the UE using reference signal (RS) index q_d for the active DL BWP, as described in clause 12, of carrier f of serving cell c

126. The Samsung 5G Accused Products further practice the step whereby the UE derives the pathloss change based on the first pathloss value and the second pathloss value. For example, this functionality is described in the 5G Standard, including but not limited to in 3GPP TS 38.321 section 5 and 3GPP TS 38.213 section 7.

3GPP TS 38.321

5.4.6 Power Headroom Reporting

…

A Power Headroom Report (PHR) shall be triggered if any of the following events occur:

- *phr-ProhibitTimer* expires or has expired and the path loss has changed more than *phr-Tx-PowerFactorChange* dB for at least one RS used as pathloss reference for one activated Serving Cell of any MAC entity of which the active DL BWP is not dormant BWP since the last transmission of a PHR in this MAC entity when the MAC entity has UL resources for new transmission;

NOTE 1: The path loss variation for one cell assessed above is between the pathloss measured at present time on the current pathloss reference and the pathloss measured at the transmission time of the last transmission of PHR on the pathloss reference in use at that time, irrespective of whether the pathloss reference has changed in between. The current pathloss reference for this purpose does not include any pathloss reference configured using *pathlossReferenceRS-Pos* in TS 38.331 [5].

3GPP TS 38.213

7.1.1 UE behaviour

. . .

- $PL_{b,f,c}(q_d)$ is a downlink pathloss estimate in dB calculated by the UE using reference signal (RS) index q_d for the active DL BWP, as described in clause 12, of carrier f of serving cell c

127. The Samsung 5G Accused Products further practice the step whereby the UE determines whether a second power headroom report is triggered based on whether the pathloss change is more than a threshold. For example, this functionality is described in the 5G Standard, including but not limited to in 3GPP TS 38.321 section 5.

3GPP TS 38.321

5.4.6 Power Headroom Reporting

…

A Power Headroom Report (PHR) shall be triggered if any of the following events occur:

- *phr-ProhibitTimer* expires or has expired and the path loss has changed more than *phr-Tx-PowerFactorChange* dB for at least one RS used as pathloss reference for one activated Serving Cell of any MAC entity of which the active DL BWP is not dormant BWP since the last transmission of a PHR in this MAC entity when the MAC entity has UL resources for new transmission;

NOTE 1: The path loss variation for one cell assessed above is between the pathloss measured at present time on the current pathloss reference and the pathloss measured at the transmission time of the last transmission of PHR on the pathloss reference in use at that time, irrespective of whether the pathloss reference has changed in between. The current pathloss reference for this purpose does not include any pathloss reference configured using *pathlossReferenceRS-Pos* in TS 38.331 [5].

128. Accordingly, as illustrated above, the Samsung 5G Accused Products directly infringe one or more claims of the '585 Patent. Samsung makes, uses, sells, offers for sale, and/or imports, in this District and/or elsewhere in the United States, the Samsung 5G Accused Products and thus directly infringes the '585 Patent.

129. Samsung has also indirectly infringed and continues to indirectly infringe the '585 Patent, as provided in 35 U.S.C. § 271(b), including at least by inducing infringement by others, such as Samsung's customers and end-users, in this District and elsewhere in the United States, to use the Samsung 5G Accused Products in manners that infringe the '585 Patent. For example, Samsung's customers and end-users directly infringe via their use of the Samsung 5G Accused Products to access and use 5G wireless technologies, infringing the '585 Patent. Samsung induces such direct infringement through its affirmative acts of making, using, selling, offering to sell,

and/or importing the Samsung 5G Accused Products, as well as by advertising its 5G wireless technologies and providing instructions, documentation, and other information to its customers and end-users to encourage and teach them how to use the infringing 5G wireless technologies, including but not limited to by Samsung providing in-store and online technical support, marketing materials, product manuals, advertisements, and other product documentation. Samsung performs these affirmative acts with knowledge of the '585 Patent and with the intent, or willful blindness, that the induced acts directly infringe the '585 Patent.

130. Samsung has also indirectly infringed and continues to indirectly infringe the '585 Patent, as provided by 35 U.S.C. § 271(c), by contributing to direct infringement committed by others, such as Samsung's customers and end-users, in this District and elsewhere in the United States. Samsung's affirmative acts of selling and offering to sell the Samsung 5G Accused Products in this District and elsewhere in the United States, and causing the Samsung 5G Accused Products to be manufactured, used, sold, and offered for sale, contribute to Samsung's customers and end-users using the Samsung 5G Accused Products, such that the '585 Patent is directly infringed. The accused components in the Samsung 5G Accused Products are material to the inventions claimed in the '585 Patent, are not staple articles or commodities of commerce, have no substantial non-infringing uses, and are known by Samsung to be especially made or adapted for use in the infringement of the '585 Patent. Samsung performs these affirmative acts with knowledge of the '585 Patent and with the intent, or willful blindness, that they cause direct infringement of the '585 Patent.

131. Samsung has also infringed and continues to infringe the '585 Patent, as provided by 35 U.S.C. § 271(f)(1), by supplying or causing to be supplied in or from the United States all or a substantial portion of the components of the Samsung 5G Accused Products, uncombined in whole or in part, in such a manner as to actively induce their combination outside the United States in a manner that would infringe the '585 Patent if such combination occurred within the United

States. Samsung has likewise infringed and continues to infringe the '585 Patent, as provided by 35 U.S.C. § 271(f)(2), by supplying or causing to be supplied in or from the United States components of the Samsung 5G Accused Products that are especially made or especially adapted for infringement of the '585 Patent. The accused components in the Samsung 5G Accused Products are material to the inventions claimed in the '585 Patent, are not staple articles or commodities of commerce, have no substantial non-infringing uses, and are known by Samsung to be especially made or adapted for use in the infringement of the '585 Patent. Samsung performs these affirmative acts with knowledge of the '585 Patent and with the intent, or willful blindness, that they cause direct infringement of the '585 Patent.

132. Samsung's infringement of the '585 Patent has damaged and will continue to damage the Plaintiffs.

133. Samsung has had knowledge of the '585 Patent, and its infringement thereof, at least since January 19, 2022, when Plaintiffs provided Samsung notice that it is infringing the '585 Patent. Samsung continues without license to make, use, sell, offer to sell, and/or import the Samsung 5G Accused Products, willfully continuing Samsung's infringement.

COUNT VI: DECLARATORY JUDGMENT THAT THE PLAINTIFFS HAVE COMPLIED WITH ETSI OBLIGATIONS AND COMPETITION LAW AND THAT THE DEFENDANTS HAVE NOT

134. Plaintiffs incorporate by reference the preceding paragraphs as though fully set forth herein.

135. In an abundance of caution and to ensure their compliance with the ETSI IPR Policy, the Plaintiffs informed Samsung that they were prepared to grant Samsung a license, on FRAND terms, to the Plaintiffs' patents that relate to 4G and/or 5G wireless technologies.

136. Not later than January 19, 2022, the Plaintiffs sent Samsung correspondence initiating the Plaintiff's good faith efforts to license their patents to Samsung on FRAND terms.

137. Following the Plaintiffs' January 19, 2022 notice to Samsung, including for more than 18 months thereafter, the Plaintiffs' representatives routinely corresponded with Samsung representatives. During such correspondence, the Plaintiffs' representatives provided, in good faith, materials concerning the Plaintiffs' patents and technical details evidencing Samsung's use of the Plaintiffs' patents, including the Patents-In-Suit.

138. The Plaintiffs have provided Samsung multiple opportunities to license the Plaintiffs' patents on FRAND terms. Despite this, Samsung has not reciprocated Plaintiffs' good faith efforts. Samsung has declined to take a FRAND license, while continuing to make, use, sell, offer to sell, and import the Samsung Accused Products without a license to the Plaintiffs' patents.

139. The parties' FRAND license negotiations have been unsuccessful because Samsung has not negotiated in good faith. Samsung has failed to reciprocate the Plaintiffs' good faith efforts.

140. There is a dispute between the Plaintiffs and Samsung concerning whether the Plaintiffs' history of offers to Samsung for a global license to the Plaintiffs' patents complies with the Plaintiffs' commitment to license their essential patents on FRAND terms and conditions pursuant to ETSI and ETSI's IPR Policy. The Plaintiffs have fully performed all obligations they may have under the FRAND contract, but Samsung disagrees and, as a result, has refused to license Plaintiffs' patents on the FRAND terms the Plaintiffs have offered. Samsung has not reciprocated the Plaintiffs' efforts to negotiate a FRAND license in good faith. There is a case or controversy of sufficient immediacy, reality, and ripeness to warrant the issuance of declaratory judgment.

141. Accordingly, the Plaintiffs request a declaratory judgment by this Court finding that Plaintiffs' actions in connection with their negotiations toward a FRAND license with Samsung were conducted by Plaintiffs in good faith, complied with the ETSI IPR Policy, and were consistent with competition law requirements.

142. Further, the Plaintiffs request a declaratory judgment by this Court finding that Samsung has not negotiated with Plaintiffs in good faith, has not complied with ETSI's IPR Policy, and has waived any rights it may have under the ETSI IPR Policy.

DAMAGES

143. As a result of Defendants' acts of infringement, Plaintiffs have suffered actual and consequential damages. To the fullest extent permitted by law, Plaintiffs seek recovery of damages at least in the form of reasonable royalties.

DEMAND FOR JURY TRIAL

144. Plaintiffs hereby demand a jury trial for all issues so triable.

PRAYER FOR RELIEF

WHEREFORE, the Plaintiffs respectfully request that this Court enter judgment in their favor ordering, finding, declaring, and/or awarding Plaintiffs relief as follows:

A. that Samsung infringes the Patents-In-Suit;

B. an award of damages resulting from Samsung's acts of infringement in accordance with 35 U.S.C. § 284;

C. that Samsung's infringement of the Patents-In-Suit is willful;

D. enhanced damages pursuant to 35 U.S.C. § 284;

E. a declaration that Plaintiffs, in their history of negotiations with Samsung in regard to a global license to the Plaintiffs' patents, have negotiated in good faith and have complied with the ETSI IPR Policy and any applicable laws, and with competition law;

F. a declaration that Defendants have not negotiated in good faith, have not complied with the ETSI IPR Policy, and have waived any rights they may have under the ETSI IPR Policy;

G. that this is an exceptional case and awarding the Plaintiffs their reasonable attorneys' fees pursuant to 35 U.S.C. § 285;

H. an accounting for acts of infringement and supplemental damages for infringement and/or damages not presented at trial, including, without limitation, pre-judgment and post-judgment interest;

I. all equitable relief the Court deems just and proper; and

J. such other relief which may be requested and to which the Plaintiffs are entitled.

DATED: March 11, 2024

Respectfully submitted,

/s/ *Robert Christopher Bunt*

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**ATTORNEYS FOR PLAINTIFFS
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AND CELERITY IP, LLC**

CERTIFICATE OF SERVICE

I hereby certify that a true and correct copy of the above and foregoing document has been served on all counsel of record via the Court's ECF system on March 11, 2024.

/s/ *Robert Christopher Bunt*
Robert Christopher Bunt